DOCUMENT RESUME

ED 217 582 EC 142 424

AUTHOR Daugherty, Kathryn M.; Moran, Michael F.
TITLE Neuropsychological, Learning and Developmental Characteristics of the Sighted, Visually Impaired Child.
INSTITUTION Pittsburgh Public Schools, Pa.
SPONS AGENCY Office of Education (DHEW), Washington, D.C.
PUB DATE Dec 80
GRANT G007901959
NOTE 121p.

EDRS PRICE MF01/PC05 Plus Postage.
DESCRIPTORS Academic Achievement; Case Studies; *Cognitive Development; Elementary Secondary Education; Incidence; *Learning Disabilities; Multiple Disabilities; Neurological Organization; *Partial Vision; Student Characteristics

ABSTRACT

Fifty partially sighted children (7 to 18 years old) were studied along 143 variables to provide a comprehensive profile in the areas of cognitive, psychomotor, academic, and neuropsychological development. The Halstead-Reitan Neuropsychological Battery was the principal data collection instrument, supplemented by the Stephen's Piagetian Battery of Reasoning Assessments and standardized achievement tests. Results indicated that the sample was characterized by significant delays in cognitive and psychomotor development and academic achievement. Neuropsychological functioning was confirmed as a significant intervening variable in several developmental areas. Thirty-two Ss (65% of the total sample population) were classifiable as either brain damaged or learning disabled. Programing implications included the importance of academic remediation in reading, mathematics, and language skills in addition to stimulation of cognitive and perceptual motor functioning. (Author/CL)

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NEUROPSYCHOLOGICAL, LEARNING AND DEVELOPMENTAL CHARACTERISTICS OF THE SIGHTED, VISUALLY IMPAIRED CHILD

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Principal Investigators

Grant No. G007901959

CFDA No. 13.443C

Pittsburgh Public Schools
Richard C. Wallace, Jr., Superintendent
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The activity which is the subject of this report was supported in whole by the U.S. Office of Education, Department of Health, Education, and Welfare. The opinions expressed herein, however, do not necessarily reflect the position or policy of the U.S. Office of Education, and no official endorsement by the U.S. Office of Education should be inferred. (Grant No. G007901959)

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Acknowledgments

Every research endeavor requires the commitment and cooperation of several individuals whose work, time and support must converge to produce a meaningful product. The investigators wish to express their gratitude to those individuals who made significant contributions to the research process.

The following persons comprised the research team.

Dr. William W. Penn, Director, Division for Exceptional Children, provided strong and continued administrative support to the project from its inception. Dr. Penn served as the administrative Project Director.

Dr. Louis Pingel and Mr. James Schmidhammer, University of Pittsburgh, served as the research and statistical consultants, designing the data analysis techniques and performing the entirety of the statistical analyses and related graphics.

Dr. Irvin Chamovitz served as the consultant neurologist and assisted in the interpretation of a formidable body of neuropsychological data.

Mrs. Susan Maczka administered the Piagetian Assessment Battery to the entire sample and consulted on the interpretation of data.

Mr. Tim O'Donnel of Psychological Specialists, Inc. assisted in the administration of fifty Halstead-Reitan Batteries.

Ms. Shirley Austin of Psychological Specialists, Inc. assisted in the psychological testing and application of the Rules Analysis to the data.

Ms. Pattie Burnelis, Division for Exceptional Children, provided extensive clerical service to the project, including the preparation of the Final Report.

Dr. Al Fascetti, Director of Federal Programs, and his staff supervised the administrative and fiscal aspects of the project.

The researchers also express their gratitude to the teachers of the visually impaired, students and parents without whose total cooperation this project could not have been implemented.

Abstract

This study was conducted to provide a comprehensive profile of the sighted, visually impaired child in the areas of cognitive, psychomotor, academic and neuropsychological development. The research represents an intensive case study of 50 individuals on 143 variables. The principal data collection instrument was the Halstead-Reitan Neuropsychological Battery, supplemented with the Stephen's Piagetian Battery of Reasoning Assessments and standardized achievement tests.

Results of the study indicated that the sample of sighted, visually impaired students was characterized by significant delays in cognitive and psychomotor development and academic achievement. Neuropsychological functioning was confirmed as a significant intervening variable in several developmental areas. The high incidence of learning disabilities in this sample was substantiated by the application of the Selz and Reitan Rules Analysis (1980) and the Halstead Impairment Index to the neuropsychological data. Thirty-two subjects or 65% of the total sample population were classifiable as either brain-damaged or learning disabled.

The results of the study have implications for psychological assessment and educational programming for the visually impaired.

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NEUROPSYCHOLOGICAL, LEARNING AND DEVELOPMENTAL CHARACTERISTICS OF THE SIGHTED, VISUALLY IMPAIRED CHILD

I. BACKGROUND OF THE PROJECT

A. Documentation of the Need for Research on the Sighted, Visually Impaired Child.

This study was conducted to provide a comprehensive profile of the learning needs of the sighted, visually impaired child in the areas of cognitive, psychomotor, academic, and neuropsychological development.

Documentation of the need for this study derives from two sources: an extensive survey of the research dealing with the visually impaired and recent data on the epidemiologic aspects of visually handicapping conditions.

A review of research conducted over the past ten years in the area of the visually handicapped discloses a paucity of studies on the sighted, visually handicapped child. The majority of formal research and federally funded projects have concentrated on the development of the totally blind school aged child in the areas of cognition, communication, and social development.[1] At the same time, national data on the incidence and severity of visual handicaps have documented that the majority of school-aged persons receiving educational services related to visual handicaps are functioning as sighted individuals.

Genensky (1978) cites data from the National Academies of Science and Engineering (1970) which indicates that:

> more than 75 percent of the legally blind, with or without the help of optical or electronic optical aids, have enough residual vision to be able to use that vision to read ordinary printed or handwritten material, to write with a pen or pencil, and to maneuver safely even in an unfamiliar environment without the help of a guidedog, a white cane, or a sighted person. (p.177)

[1] In a published review of over 100 studies (Council for Exceptional Children, 1973) only four were found which specifically investigated the learning characteristics of the sighted, visually impaired child.

Genensky (1978) further analyzes data from Statistics on Blindness in the Model Reporting Area (1969-1970), concluding that "more than 93 percent of the visually impaired are partially sighted and hence less than 7 percent are functionally blind"(p. 179). Genensky also presents data which suggests that the majority of partially sighted persons have a very slim chance of ever becoming totally blind.

In regard to the school aged population, statistical studies provided by the American Printing House For The Blind (1977) document that 47% of students classified as "legally blind" are print readers with 21% using braille as their primary reading medium. An additional 34% are classified as non-readers.[2] Since it is assumed that all partially seeing children utilize large or regular print, it may be estimated that over 70% of the children being served in programs for the visually handicapped in the United States are sighted children, with only 11% classified as braille readers.

Two reasons have been postulated to account for this shift in population. A primary factor is the pedagogical emphasis on the utilization of residual vision coupled with refinements in surgical treatment and low vision aides which have enabled many students who were previously educated as "blind" to be educated as seeing (Apple & May, 1971; Ascroft, 1965; Barraga, 1964). A second factor derives from etiological considerations. The major cause of pediatric blindness in the 1950's was retrolental fibroplasia which has largely been eliminated through changes in the primary care of the premature child.

Despite medical and educational research which has documented that distinct changes have occurred in the population of visually handicapped students being served, little research has been generated which addresses the specific educational needs of this population.

[2]This population includes preschool children and the multiply handicapped.

> Pinter summed up our knowledge about this aspect of partially sighted children when he maintained in 1941, "About the children themselves from a psychological point of view we know practically nothing." Fourteen years later, in summarizing our current knowledge, Lowenfeld stated that "...conditions have not changed to a considerable extent."
>
> Kirk, Educating Exceptional Children, 1962.

The lack of hard data regarding the learning characteristics of the visually impaired population currently being served raises a serious question concerning the appropriateness of curriculum and educational techniques being advocated for them. With the implementation of Public Law 94-142 and concomitant development of Individualized Educational Program Plans, there exists a need for validating curriculum in relation to the learning needs of the population being served. In the area of education for the visually handicapped, the impetus for identifying learner characteristics has been directed toward the nonvisual learner in the areas of communication skills, mobility, cognitive development and technological aides.

It was a central premise of this project that research on the development of the totally blind child may not necessarily be generalized to the sighted, visually impaired child and that modifications of curriculum and teaching methodology used for the totally blind may not be appropriate for the congenitally impaired, seeing child. An overview of descriptive research on visually impaired children suggests that this population is characterized by academic, motor and cognitive deficits which may not be addressed by traditional curricula utilized for the blind child. For the purpose of this investigation, it was assumed that the visually impaired population constitutes a highly heterogeneous group of individuals, characterized by differences in etiology and developmental disabilities. The term "sighted, visually impaired"

is defined as:

> Those school aged persons who have a congenital, physical visual impairment ranging from mild to severe, who are identified as educationally visually handicapped and who use print as the primary reading medium.

B. Developmental and Learning Characteristics of the Sighted, Visually Impaired Child: Review of the Literature

Variables selected for the present investigation were derived from an extensive review of literature of the developmental aspects of visual disability.

Psychomotor Development

Various researchers have suggested that visually impaired students exhibit significant degrees of psychomotor retardation. Cratty (1971) in a systematic study which compares totally blind and partially sighted students on a test of body image, finds that sighted, visually impaired students perform significantly poorer on tasks which require body identification and realization of spatial relations than the totally blind. Maxfield and Bucholz (1957) studied 484 blind children for the purpose of establishing normative data for the Maxfield-Bucholz Scale of Social Maturity, an adaptation of the Vineland Social Maturity Scale (Doll, 1953). Normative data collected for this study discloses major developmental deficits of "blind" infants, particularly in areas which dealt with self-initiated mobility. Of interest, the "blind" sample of 484 children, consisted of 64% with retrolental fibroplasia (RLF) who had more than light perception, with 48% of the non-RLF sample having more than light perception. These data suggest that the Maxfield-Bucholz Scale was standardized on a predominantly seeing sample, or those with the potential to see. No attempt was made to differentiate developmental levels relative to varying degrees of visual acuity.

Karnes and Wollersheim (1963), in a study of sixteen partially sighted students, found that visual abilities were generally inferior to auditory and vocal abilities. Gibbs and Rice (1974), in an investigation of visually impaired learners' performance on the ITPA, support Karnes's finding that even mild degrees of visual impairment adversely affect visual-receptive and motor-expressive skills.

The limited data available on the psychomotor development of the sighted, visually impaired child suggest that he/she is characterized by mild to severe degrees of psychomotor retardation. Cratty's (1971) research further suggests that partially seeing students may exhibit greater deficits than their totally blind peers in the areas of body image and spatial relations. No attempt was made in these studies to relate the findings to other covariables such as retardation, neurological impairment or perceptual dysfunction.

This study investigated the psychomotor functioning of children with visual handicaps and explored the relationship of this variable to neuropsychological functions and degrees of visual disability.

Cognitive Development

A review of the literature disclosed that the bulk of research concerning the cognitive development of the visually handicapped has been directed toward the congenitally, totally blind child.

A major study conducted by Stephens (1974) studied the cognitive development of the blind using Piagetian theory. When 75 congenitally blind subjects, ages 6-18, were compared with 75 sighted subjects, ages 6-18, on a continuum of Piagetian reasoning tasks, it was found that blind students exhibited "an overall lag of approximately eight years in the development of reasoning" (p.3).

The most serious deficits were found to be in the areas of logical thought which involved spatial orientation and mental imagery. Stephens accounts for these findings by postulating that the lack of vision serves to curtail the interaction of the blind child with the environment, consequently retarding the process of assimilation and accommodation.

Although this study was not duplicated with sighted, visually handicapped students, limited research data suggest that this population may exhibit cognitive deficits similar to those of blind children. Swallow and Paulsen (1973)

studied ten visually limited adolescents in their conception of space and report a lag in development of spatial concepts at the level of concrete operations. They subsequently conclude that "lack of sufficient physical encounters is probably more detrimental (to development) than loss of vision."

Since research cited previously (Cratty, 1971; Maxfield & Buchholz, 1957) documents psychomotor and spatial-conceptual retardation of the sighted, visually impaired, it may be inferred that these deficits are related to concomitant lags in cognitive development. The rationale for this assumption derives from Piagetian theory and the observed curtailing influence of reduced vision on the acquisition of sensory-motor landmarks. Research conducted by Fraiberg and Adelson (1976) documents that a reduction in afferent stimulation is related to delayed motor functioning. The Piagetian Model of infant intelligence stresses the parallel acquisition of sensory-motor and perceptual skills. For example, the act of reaching is expected to be observed with the sighted infant at the age of 4 months. This motor landmark is associated with the beginning of the stage of secondary circular reactions which marks the emergence of the concept of stability of space and a repetition stage of activity in which eye-hand coordination is gradually refined. The secondary circular reaction is followed by the coordination of secondary schema in which object permanence is achieved and purposeful behavior is initiated. Thus, by the end of his first year, the fully sighted infant begins problem solving on a trial and error basis, a process which occurs concurrently with refinements in basic locomotor movements.

In contrast, observations of blind infants document that the mean age for "reaching behavior" is 10.5 months (Fraiberg and Adelson, 1976). It may be hypothesized that this delay, in addition to similar delays in initiating behavior such as creeping, crawling and walking are associated with concurrent

delays in perceptual development and the subsequent acquisition of concepts, culminating in the progressive cognitive delays which Stephens observed in a school-aged population of blind students.

It was the intent of this study to investigate the cognitive development of visually impaired children who are functionally sighted, but whose cognitive and psychomotor development was presumably affected by reduced visual stimulation. The methodology of Stephens and Simpkins (1974), utilizing the adapted battery of Piagetian reasoning assessments, was replicated in the current research.

Academic Achievement

A study by Birch, Tisdall, Peabody and Sterrett (1966) which investigates the school achievement of 1,084 partially sighted children in grades 5 and 6, discloses that there is a significant degree of educational retardation among these students. The partially sighted student with average intelligence was found to be one year behind in overall academic achievement and one year, nine months overage for grade placement. Karnes's (1963) study of partially seeing learners reveals a discrepancy between ability and academic achievement at the .05 level. Daugherty (1978) in a study of 45 visually impaired print readers in grades one through twelve, documents that learners in this sample were an average of 2.17 years behind in oral reading skills and 0.80 years behind in mathematics achievement relative to age/grade placement. In general, the research supports the finding that visually impaired print readers are an average of two years behind their fully sighted counterparts in academic achievement, even with the provision of highly specialized services. Taylor (1973) raises the question regarding the sample characteristics of these studies.

> The question arises whether these children found their way into a program for partially seeing children because of their visual problem or because of their educational problems, which may involve learning or other disabilities not associated with visual defects (Lowenfeld, 1973, p. 176).

A central premise of this investigation was that "learning or other disabilities" may indeed be associated with visual defects. In certain cases, visual defects, in themselves, may be symptomatic of neurologically or developmentally rooted learning-deficit syndromes. Research on the academic achievement of visually impaired, print readers suggests that such students are functionally similar to those with learning disabilities in the areas of underachievement and specific learning deficits. An overview of specialized curricula to meet the needs of the visually handicapped suggests that most models do not typically emphasize remedial or process-oriented instruction.

Neuropsychological Development and Visual Impairment

Gregory (1966) defines the retina as "an outgrowth of the brain" (p.45).

> It (the retina) is a specialized part of the surface of the brain which has budded out and become sensitive to light, while it retains typical brain cells lying between the receptors and the optic nerve (but situated in the front layers of the retina) which greatly modify the electrical activity of the receptors themselves. Some of the data processing for perception takes place in the eye which is thus an integral part of the brain. (Gregory, 1966, p. 46)

The eye has been documented to be a physiological outgrowth of the brain, yet relatively few research studies have investigated the relationship between neuropsychological variables and the behavioral and learning manifestations of a visual impairment.

The majority of research studies reviewed for the present proposal investigated the relationship between "blindness" or "partial vision" as defined by distance visual acuity and educational variables. A paucity of

research was found which investigates the relationship between ocular pathology and learning/behavior characteristics where neuropsychological involvement was also considered as an intervening variable.

Neuropsychological development of the visually limited, or blind child, may be viewed as an antecedent or consequent variable (Table One). For example, in instances such as optic atrophy, cortical blindness, or degenerative retinal disease, the visual impairment may be a secondary manifestation of central nervous system dysfunction. Novikova (1973) cites research by Dyer and Bierman (1950, 1952) which found that a maximum number of pathologic, neurologic signs were found in patients with amblyopia combined with strabismus. Neuropsychological development may also be viewed as a consequent variable, related to early somatosensory deprivation. Novikova's (1973) extensive study of the neurological manifestation of blindness and partial vision in children reveals marked neurodynamic shifts arising in the central nervous system. She further relates the depression of alpha waves and general cortical activity to a lack of visual afferentation.

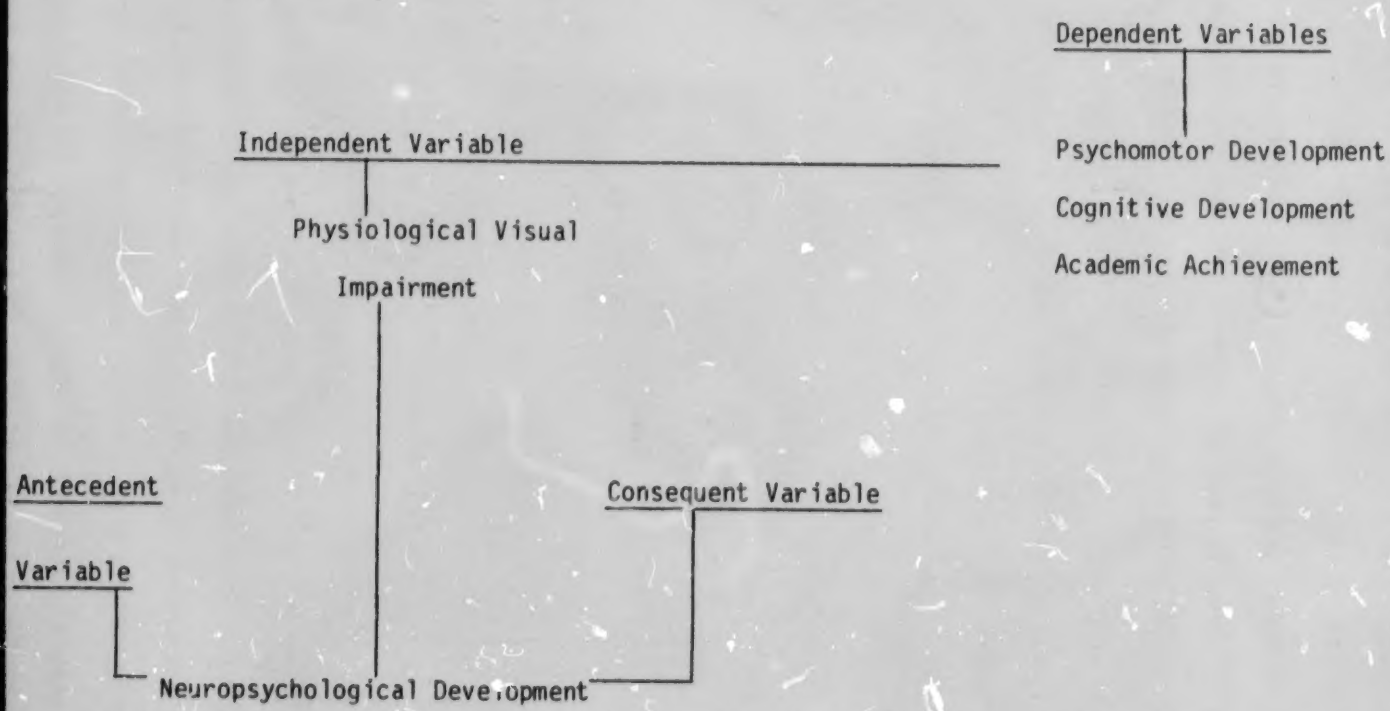
> "If the visual acuity is from 0 to 0.05 (NLP to 20/400) one can observe, together with the suppression of alpha rhythm, a depression of the electrical potentials in all areas of the cortex, particularly in the occipital area" (p. 177).

Novikova's research suggests that an impairment to the visual system resulting in a depressed stimulation of the retina and cortical pathways, contributes to a <u>different</u> neurodynamic picture from what would normally be seen in a fully sighted child.

In general the literature on pediatric development tends to negate a direct relationship between peripheral visual impairment and neurological impairment. However, Novikova's research suggests that, without labeling the neurodynamic system as <u>impaired</u>, it may be postulated that the neurological

TABLE I

Summary of Research Variables



development of the child with impaired vision is different.

It was the intent of this study to investigate the neuropsychological development of the sighted, visually impaired child as part of a composite of factors which affect that child's learning characteristics.

Higher levels of human adaptive behavior, such as learning new material and the processing of various forms of information, are entirely dependent upon the integrity of neuroanatomical mechanisms, i.e., the central nervous system. It can therefore be reasonably assumed that learning disorders and information processing deficits in fact reflect dysfunctions or disorders within the central nervous system itself. For example, expressive and receptive aphasic disorders and the ability to decode and extract meaning from printed or graphic stimuli each represent differential dysfunctions in specific cortical areas. (Hartlage, 1981). Necessarily, then, the diagnosis of learning problems for the purpose of rendering appropriate educational prescriptions involves a detailed mapping of cortical strengths and weaknesses.

Even where there is no conventional medical or neurological evidence of brain damage, the brain functions of learning-disabled children deviate significantly from control subjects when they are assessed with neuropsychological instruments, such as the Halstead-Reitan Battery (Selz & Reitan, 1980).

Research in cerebral hemisphere specialization has produced results with dramatic implications for psychoeducational assessment practices and for the developmental of individual educational prescriptions. Reitan (1955), Klove (1965) and Parsons, Vega, and Burn (1969) all demonstrate that in most adults the left cerebral hemisphere is specialized for language functions and the right cerebral hemisphere is more involved in mediating spatial forms of information. In general, the Wechsler Verbal Subtests reflect functions of the left cerebral hemisphere while the Performance Subtests measure functional

levels of the right cerebral hemisphere. In addition to processing verbal symbols and language information, the left cerebral hemisphere is more specialized than the right cerebral hemisphere for such cognitive functions as sequential, logical and analytical thinking processes; the right cerebral hemisphere is more specialized for processing holistic, gestalt or configurative forms of information and visual stimuli (Cohn, 1971; Gordon, 1975) and the emotions (Schwartz, et al., 1975).

Medially located cortical areas are more involved in motor functions while anterior brain areas are more specialized in planning, evaluative and judgmental thinking processes. Posterior brain functions include sensation and perception, with purely visual functions located in the most posterior region. The brain enervates contralaterally for motor, sensation and perceptual functions; that is, the right hemisphere controls activities of the left side of the body and vice versa.

Discrete brain areas specialize in discrete, measurable functions along anterior to posterior and right to left cerebral hemisphere areas. For example, expressive speech functions are controlled by the anterior portion of the left cerebral hemisphere while receptive speech, involving visual and auditory avenues, is a function of the posterior temporal and adjacent cortical areas of the same hemisphere. Extracting meaning from printed language is a function of an even more posterior area of the left cerebral hemisphere, closer to the occipital lobe.

Differential memory functions are likewise represented in accordance with the form of the material to be remembered. Thus, memory for verbal material is most likely a function of the left cerebral hemisphere, while memory for spatial configurations is related to functions of the right cerebral hemisphere (Ladavas, et al., 1979; Milner, 1971).

The psychological and educational implications of human cerebral hemisphere specialization are critical. Discrete cortical dysfunctions or asymmetry of the cerebral hemispheres could result in significant perceptual, motor behavioral and/or information processing deficits which are associated with learning problems. It seemed to be essential, therefore, to assess the pattern of neurological organization among sighted, visually impaired students and to construct a profile of neuropsychological strengths and weaknesses for this population. This information is seemingly a necessary component to any realistic basis for restructuring curricula, for revising educational methodology and for developing academic remediation activities for the sighted, visually impaired. Intraindividual and interindividual patterns of uneven levels of neurological organization notwithstanding, it is nonetheless obviously advantageous for educational purposes to diagnose and describe common cortical assets and liabilities for a typical student population in a public school special education program for the visually impaired.

There are in existence several comprehensive neuropsychological test batteries. However, at the present time there is a general consensus among physicians and psychologists that the Halstead-Reitan Neuropsychological Battery is the assessment technique of choice for refined, precise and sophisticated measurements of cortical functions (Hartlage, 1981). The development and widespread use of this battery in research over many years has substantiated this assessment technique's fidelity, sensitivity, and reliability in detecting both gross and subtle changes in the levels of functioning in discrete areas of the central nervous system. The complete Halstead-Reitan Battery is described in detail in Appendix B of this research report.

It is important to note, however, that Reitan and Selz (1980) have demonstrated that neuropsychological data, using the Halstead-Reitan Battery,

are significantly related to learning disabilities in contrast to the results of neurological examinations provided by physicians. Even where there is no medical evidence of brain damage, the results of comprehensive neuropsychological assessments can clearly establish that the brain functions of the learning disabled deviate significantly from the brain functions of control subjects.

For research purposes, Reitan (1980) postulates that control subjects are normal on both higher-level and lower-level manifestations of brain functions. Further, he postulates that learning-disabled individuals are normal on lower-level brain functions, but tend to display impairment on tests of higher-level functions and that subjects with definite brain damage exhibit impaired function in both the higher- and lower-level categories.

Again, for research purposes, Reitan assigns the various tests in his battery to one of two categories: those that measure higher-level functions and those that measure lower-level brain functions. The following chart reflects Reitan's division of his Battery of tests into categories of Higher and Lower-level measures.

Higher- and Lower-Level Measures of Brain Functions

Higher-Level Measures

1. Category Test
2. Tactual Performance Test (Total Time)
3. Trail Making Test - Part A
4. Trail Making Test - Part B
5. Speech Sounds Perception Test
6. Seashore Rhythm Test
7. Wechsler Verbal IQ
8. Time difference between dominant and nondominant hand in writing one's name
9. IQ Pattern

Aphasia

10. Dysnomia
11. Spelling Apraxia
12. Dysgraphia
13. Dyslexia
14. Central Dysarthria
15. Dyscalculia
16. Right-Left Confusion
17. Auditory Verbal Dysgnosia
18. Visual Number Dysgnosia
19. Visual Letter Dysgnosia
20. Body Dysgnosia

Lower-Level Measures

21. Memory Component of the Tactual Performance Test
22. Localization Component of the Tactual Performance Test
23. Wechsler Performance IQ
24. Finger Tapping-Preferred Hand
25. Finger Tapping-Nonpreferred Hand
26. Name-writing with Preferred Hand
27. Tactile Finger Recognition-Difference
28. Finger Tip Number Writing-Difference
29. Sensory Imperceptions
30. Tactile Finger Recognition-Errors
31. Finger Tip Number Writing-Errors
32. Tactile Form Recognition
33. Grip Strength (Right-Left Differences)
34. Finger Oscillation Test (Right-Left Differences)
35. Tactual Performance Test - Time difference between right and left hand

Aphasia

36. Constructional Apraxia

For the purpose of obtaining data related to the variables presented on Table One, the Halstead-Reitan Neuropsychological Battery was utilized to examine the cortical functions of the sighted, visually impaired school-aged child.

C. Traditional Instructional Models for the Visually Impaired

Special curricula for partially seeing students have traditionally included: "sight utilization training, auditory training and listening skills development, basic orientation and mobility techniques and typewriting" (Special Education Standards of the Pennsylvania Department of Education, 10/2/72). Barraga (1976) also includes "personal competencies and self-adjustment" and "prevocational information." In regard to the academic curriculum, Barraga (1976) states:

> The general practice in educational programming for visually handicapped children, especially in local schools, has been to parallel the academic curriculum of the sighted, although providing different materials, equipment and teaching devices. The assumption that this enabled children to learn the same academic subjects that their sighted peers learned was not based on an objective appraisal of functional achievement. (p. 69)

"Objective appraisals" which have been done (Bateman, 1963; Birch et al., 1966; Karnes and Wollersheim, 1963) suggest that partially seeing students generally remain chronic underachievers when educated using this model. Many components of traditional curricula, designed to meet the needs of the partially sighted, are derived from theoretical postulates of what constitutes "the handicapping condition," rather than on rigorous studies of the learning and behavioral characteristics of this population.

Concurrent with the lack of research and child-study activities which address the learning characteristics of the visually handicapped, an abundance of literature has been generated which examines the competencies needed by teachers to educate these students (Spungin, 1978). The general approach to identifying competencies for teachers of the visually handicapped has been to generate a core group of competencies (typically by a panel of experts in the "field") and to solicit validation of these competencies by surveying educators. The assumption behind this research approach is that teachers, who work

on a daily basis with students who are visually handicapped, can accurately identify those competencies which are appropriate to meet learning needs. Ostensibly, this is a valid method of differentiating what is and what is not effective in terms of teacher activities. Without negating the validity of studies on teacher competencies, it is suggested that the technique of consensual validation may lack objectivity. Specifically, if teachers of the visually handicapped graduate from teacher-training programs which stress selected competencies (i.e., consultant skills, braille, mobility, typing and listening) and subsequently concentrate on these special skill areas with students (to the exclusion of others), it follows that these areas will be rated higher than other competencies. Such a cyclical procedure eliminates one very important element, the needs and characteristics of the students which these competencies purport to address.

This investigation represents an attempt to systematically study the learning characteristics of the sighted, visually impaired child in the areas of cognitive, psychomotor, academic and neuropsychological development. The model chosen for the investigation utilizes the case study approach and multivariate statistical techniques. The sample of children identified for this study was considered to be typical of the majority of visually handicapped students served in day school programs across the country. They were clinically diagnosed as congenitally visually impaired; they were functionally sighted and they represented a spectrum of economic, ethnic and social groups.

D. Goals and Objectives of the Project

Limited research on sighted, visually impaired children suggests that this population, which constitutes the majority of children being served in Programs for the Visually Impaired in the United States, is characterized by varying degrees of psychomotor, cognitive, and academic retardation. Research on curriculum models utilized to serve these children suggest they are receiving a "diluted version" of what was originally designed for the blind child, in the areas of orientation and mobility, listening and other communication skills. Few studies were found which attempted to diagnose differentially cognitive functioning, academic achievement or learning styles.

The goal of this investigation was to provide a comprehensive profile of the cognitive, psychomotor, academic and neuropsychological characteristics of the sighted, visually impaired child. The following specific objectives were related to this goal:

1.0 To describe patterns of cognitive development of the sighted, visually impaired child.

2.0 To investigate patterns of psychomotor development of the sighted, visually impaired child in the areas of gross motor, fine motor and visual-motor skills.

3.0 To identify ability/achievement discrepancies of the visually impaired child in the areas of mathematics and reading achievement.

4.0 To relate deficits in cognitive, psychomotor and academic achievement to different categories of ocular pathology and neuropsychological development.

5.0 To investigate the presence of concomitant neurological impairments in relation to categories of ocular pathology.

6.0 To develop a paradigm of differential diagnosis for the sighted, visually impaired child who manifests characteristics of other learning disorders.

7.0 To provide a profile of the sighted, visually impaired child's

learning needs which can be utilized for the development and evaluation of Individualized Educational Program Plans.

8.0 To create an aggregate data base upon which to generate further research on the sighted, visually impaired child.

II. DESIGN OF THE RESEARCH AND COLLECTION OF DATA

A. Research Design - Summary

The research methodology encompassed three basic components, using inter- and intra-group and individual comparisons:

1. An extensive case study of a sample of 50 sighted visually impaired students, approximately 50% of whom met the criteria of legal blindness and 50% of whom were partially seeing. Each case study involved six hours of testing with the Halstead-Reitan Neuropsychological Battery (as described in Appendix B) and the Stephen's Piagetian Battery of Reasoning Assessments, Short Form A.

2. Comparison of data collected on the sighted, visually impaired child with normative data provided by standardization samples used in developing the selected instruments.

3. An extensive intra-group analysis of data using correlational techniques, factor analysis and one tailed t-tests to ascertain relationships in the stated research hypotheses. (Examples are: the frequency of positive neurological signs to etiology of visual defect; abstract reasoning to Piagetian cognitive attainment; reading achievement deficits to visual acuity.)

Although this investigation was essentially descriptive in nature, the following research hypotheses were formulated based on an extensive review of the existing literature.

1.0 Sighted, visually impaired children demonstrate significantly greater intertest scatter on subtests of the Wechsler Intelligence Scale for Children-Revised (WISC-R) and Wechsler Adult Intelligence Scale (WAIS) which measure abstract reasoning and comprehension, when compared to the normative population.

1.1 Sighted, visually impaired children demonstrate a significant discrepancy between the Verbal and Performance subtests of the WISC/WAIS, as compared to the normative population.

1.2 Sighted, visually impaired children demonstrate a significant lag in the Piagetian developmental tasks of conservation, classification, one-to-one correspondence and formal reasoning when compared to a normative group of sighted peers.

2.0 Sighted, visually impaired children demonstrate a significant lag in gross motor, fine-motor and visual-motor development as measured by the Halstead-Reitan Neuropsychological Battery when compared to the standardization group of sighted peers.

2.1 There is a significant positive correlation between a measured lag in motoric development and positive neuropsychological indicators on the Halstead-Reitan.

3.0 Sighted, visually impaired children demonstrate ability/achievement discrepancies in the areas of reading and mathematics as compared to a normative group of sighted peers.
Reading achievement is on the average two years delayed.
Math achievement is on the average one year delayed.

3.1 Reading deficits are more closely related to cognitive factors and positive neurological signs than objective measures of visual acuity.

3.2 Deficits in mathematics achievement are more closely related to cognitive factors and positive neurological signs than objective measures of visual acuity.

4.0 Among children with diagnosed retinal pathology, the incidence of positive neurological signs will be greater than in those children with simple refraction errors.

4.1 There is a significant positive correlation between deficits in cognitive development as measured by the Piagetian Assessment Battery and delayed neurological development.

In addition to the analyses performed in relation to the stated hypotheses, other analyses of the data were performed as a new methodology became available. For example, in July, 1980, Reitan's Rules Analysis for Neuropsychological Diagnosis (Selz & Reitan, 1980) was made available to the researchers. The Rules Analysis provided a totally new model for describing data in the 9-15 age group, which was not available at the inception of the study and as such, was incorporated into the final analysis (Section III-F).

Data were presented as judged appropriate for each hypothesis. For example, data related to the Piagetian Assessment Battery were not amenable to parametric statistical analysis and, as such, were presented in terms of percentages. Data derived from standardized psychological tests were presented in the form of tables and Box-and-Whisker plots.

For a given set of scores, the Box-and-Whisker plots presented are constructed by first drawing an elongated box that extends from the first quartile, Q_1, to the third quartile, Q_3. Next a line is drawn across the box at the median and, finally, lines ("whiskers") are drawn from each end of the box to the corresponding minimum and maximum values.

The Box-and-Whisker plot was developed by John Tukey and presented in his book Exploratory Data Analysis (Tukey, 1977); it is sometimes called a "box plot" (e.g., see McGill, Tukey, & Larson, 1978). Tukey calls the first and third quartiles the "lower and upper hinges" and the minimum and maximum values the "lower and upper extremes." Also, Tukey calculates values of the hinges and the median in a slightly different way from the way they were calculated in the present study. In spite of these differences, the purpose of a Box- and-Whisker plot is to give information on the four quarters of a distribution in such a way that the middle 50% of the score is highlighted.

In addition to construction of the basic Box-and-Whisker plots, a plus sign is drawn in the box at the mean (see Leinhardt & Leinhardt, 1980) in order to allow comparison of the mean and median from the schematic plot itself. Also a dashed line is

drawn across each figure to indicate the mean value of the standardization group for the variable(s), or test(s) involved so that a rough comparison between the students in the present study and those in the standardization group can be made.

B. Sample

Fifty subjects were selected for the case studies.* The method of subject selection was as follows: All legally blind students enrolled in the Pittsburgh Public Schools (excluding those identified as educable mentally retarded) were included in the sample. The rationale for including all the non-multiply handicapped blind was that this group was most representative of the true low vision population, (legally blind according to medical criteria but functionally seeing). An additional 30 students were selected from the partially sighted population using stratified random sampling techniques in an effort to approach age, sex and racial balance. All the students were educationally identified as visually handicapped by medical evidence which documented a congenital, physical impairment associated with a significant reduction in distance visual acuity and/or a field restriction. All students were served in resource or itinerant programs for the visually impaired and mainstreamed in regular programming for 25-50% or more of the school day.

Several factors were considered in delimiting the sample size to 50 subjects. The intent of the research was to do an extensive evaluation of the relationship of visual factors to cognitive, psychomotor, and neuropsychological variables. The study represents an intensive case study of 50 individuals on 143 variables per subject. Since this type of research was virtually unprecedented in the literature, it was decided to develop a new model which would generate hypotheses for future, large scale research.

Secondly, a review of federally funded research projects disclosed that 50 subjects represented the upper range of sample size for projects of

*Initially the sample comprised 51 subjects; one was elminated from the neuropsychological testing due to illness.

this scope and duration. Selma Fraiberg's (1974) study of congenitally blind infants comprises a total sample of 10 children. Karnes and Wollersheim (1963) includes a sample of 16. Stephen's (1976) study of Piagetian Cognitive Development includes a sample of 75 blind children.

Thirdly, the visually handicapped constitute the lowest incidence disability group (1 per 1000). The 50 students who participated in this study represented 36% of the total population of visually impaired students enrolled in the Pittsburgh Public Schools, with a total school population in 1979-80 of 48,000 students. As such, the sample represents the economic and racial composition of a large urban environment.

The subjects ranged in age from 7-18. Forty-nine per cent of the subjects were black and 51% white. Males constituted 62.7% of the sample, and females, 37.3%. Twenty-one subjects were legally blind, and 30 partially seeing by medical/legal standards; 74.5% had non- retinal visual refractive errors and 25.5% or 13 subjects had verified retinal pathology. Mild impairment ratings were assigned to 37.3% of the sample (visual acuity in excess of 20/70). Moderate ratings (visual acuity greater than 20/200 but 20/70 or less) were assigned to 21.6% of the sample and severe ratings (visual acuity equal to or less than 20/200) were assigned to 41.2% of the subjects. Table Two describes the sample by primary etiology of visual impairment.

All the subjects utilized regular or large print as their primary reading medium.

TABLE 2

Description of Sample by Primary Etiology of Visual Impairment

	Legally Blind	Partially Sighted
Myopia	2	12
Myopia with Astigmatism	3	2
Hyperopia		1
Hyperopic Astigmatism		6
Esotropia		1
Strabismus		1
Cataract	4	
Optic Atrophy	4	
Congenital Amblyopia		1
Congenital Glaucoma	1	1
Coloboma of Iris	1	
Congenital Nystagmus	2	1
Retinal Degeneration	1	1
Congenital Retinal Malformation	1	
Uveitis	1	
Corneal Opacity	1	1
Retrolental Fibroplasia		1
Retinitis Pigmentosa		1
	n=21	n=30

III. RESULTS OF THE STUDY

A. Patterns of Cognitive Development

Hypothesis 1.0

Sighted, visually impaired children demonstrate significantly greater interest scatter on subtests of the Wechsler Intelligence Scale for Children-Revised (WISC-R) and Wechsler Adult Intelligence Scale (WAIS) which measure abstract reasoning and comprehension, when compared to the normative population.

Methods of Data Collection and Analysis

Each subject was tested individually with the WAIS or WISC-R as a component of the Halstead-Reitan Neuropsychological Battery. Raw scores for each of the twelve subtests were converted to scaled scores and averaged, yielding a total sample protocol, a protocol for the legally blind and a protocol for the partially seeing. For the WISC-R, all differences of three or more points between all possible pairs of subtests scores, and for the WAIS, all differences of five or more points between all possible pairs of subtest scores were tallied.* The tallies were subsequently converted to percentages. An additional test of significance was performed on the observed difference between the Verbal and Performance IQ.

Results

Figures One through Four present the Box-and-Whisker plots of the Verbal IQ, Performance IQ, Full Scale IQ, and the difference between the Verbal IQ and Performance IQ (VIQ - PIQ) for the total sample, the legally blind and the partially seeing. Table Three presents the data from which these plots were constructed. The assumption that the visually handicapped constitute a heterogeneous population was confirmed by the range of scores in the WISC-R/WAIS data. For example, the range of Verbal IQ's for the total sample was 62-136, 48-121 for Performance IQ,

*These correspond to the .05 level of significance as specified by the WISC/WAIS Manuals and Matarrazzo (1976).

and 51-123 for the Full-Scale IQ. This finding was observed despite a screening procedure which eliminated from the sample any subject who was educationally identified and placed as mentally retarded. Data analysis also suggested greater variance in the subsample of legally blind students (subjects with a visual acuity of 20/200 or less) than in the partially seeing subsample (subjects with a visual acuity in excess of 20/200). Legally blind subjects were also found to have a higher mean Verbal IQ ($\bar{X}$ = 97.3) than the partially sighted ($\bar{X}$ = 91.3), but with a greater disparity between Verbal and Performance IQ's ($\bar{X}$ = 17.10) than the partially sighted ($\bar{X}$ = 1.96).

Figures Five through Seven depict the Box and Whisker Plots for the interest scatter of the WISC-R/WAIS subtest scaled scores. Table Four presents the data from which these plots were constructed. Large subtest variability was apparent, particularly on the performance subtests. A serendipitous finding was the elevated average scaled score of the legally blind on the verbal Similarities subtest. Diminished sensory input combined with an assumed restriction in interactive experiences would suggest an impairment in abstract verbal reasoning for this subsample; however, this was not found. The Similarities subtest and its nonverbal assessment analog, Block Design, were subjected to further statistical analysis in addition to tests of significance between all combinations of subtests on the WISC-R/WAIS. The results for the scatter analysis, expressed in percentages, are presented on Tables Five, Six, and Seven. When the five Verbal subtests of the WISC-R/WAIS were analyzed via a matrix, the highest percentage of subjects displayed significant scatter on the Similarities subtest relative to the

other Verbal subtests. The frequency data supported a trend of the subjects to score higher on Similarities than Information (25.5%), Arithmetic (21.6%), Vocabulary (21.6%) and Comprehension (27.5%). When the reverse situation was analyzed, fewer subjects were found to score significantly higher on the other Verbal subtests relative to Similarities. For example, Vocabulary is generally used as a clinical baseline for verbal integrity in scatter analysis. In only one instance did a subject score significantly higher on the Vocabulary than the Similarities Subtest. A similar trend was noted when the nonverbal analog, Block Design, was compared to the other Verbal subtests. With the exception of the Comprehension Subtest in which 25.5% of the subjects scored significantly higher than on Block Design and 25.5% significantly lower, there was a trend for subjects to score significantly higher on Block Design as compared to the other subtests. Although the results supported significant scatter in abstract verbal and nonverbal reasoning, the direction of the scatter was not supported by previous research studies, i.e., it was not anticipated that visually handicapped subjects would display relative strength in areas of abstract reasoning. Since other tests in the protocol yielded different and conflicting results in this area (The Reitan Category Test and the Piagetian Formal Reasoning Test), it was necessary for the researchers to define functionally each of the four measures of abstract reasoning for analysis. This issue is addressed in the section labled Discussion.

The average scaled score for Comprehension was 8.74 which did not significantly deviate from the other Verbal scaled score averages. The

greatest percentage of subjects who displayed scatter in relation to Comprehension manifested higher scaled scores on Similarities (27.5%) and Block Design (25.5%).

Hypothesis 1.1

> Sighted, visually impaired children demonstrate a significant discrepancy between the Verbal and Performance subtests of the WISC/WAIS as compared to the normative population.

Methods of Data Collection and Analysis

The difference between Verbal and Performance IQ's on the WAIS and WISC-R was calculated for each subject. Box-and-Whisker plots were constructed for Full Scale IQ, Verbal IQ, Performance IO, and VIQ - PIQ for the total sample, legally blind and partially seeing. For the WISC-R, differences of VIQ minus PIQ were tallied as follows: a) smaller than -12, b) larger than +12, c) either smaller than -12 or larger than +12. For the WAIS, the same differences were tallied relative to a criterion of 20.*

Results

Data Analyses are presented in Figure Four and Tables Three and Eight. The average observed difference of Verbal IQ minus Performance IQ was 8.19 for the total sample, 17.1 for the legally blind and 1.96 for the partially seeing. For subjects who were assessed with the WISC-R, 61.9% exhibited significant differences between the Verbal and Performance IQ's of 12 points or more. For subjects assessed with the WAIS, 11.1% exhibited significant differences between the Verbal and Performance IQ's. Of the total sample, 27 subjects (52.9%) exhibited significant differences between the Verbal and Performance IQ's; of

*These correspond to the .05 level of significance as specified by the WISC/WAIS Manuals and Matarrazzo (1976).

these 7 or 13.7% were negative differences due to a significantly higher performance IQ and 20 or 39.2% were positive differences in favor of the Verbal IQ. The data supported the hypothesis that sighted, visually impaired subjects demonstrate greater significant scatter than what would be found in a normative population. An unexpected finding was that seven of the subjects exhibited significant differences in favor of the Performance IQ. All these subjects were partially seeing and six of the seven had Reitain Rules Analysis Scores which placed them in the range of the learning disabled or brain damaged. It might be hypothesized that, even with diminished vision and a reduction in perceptual motor speed, these subjects manifested a global learning impairment which was characterized by arrested verbal growth or overcompensation in the visual-motor area despite a physical visual impairment.

Hypothesis 1.2

> Sighted, visually impaired children demonstrate a significant lag in the Piagetian developmental tasks of conservation, classification, one-to-one correspondence and formal reasoning when compared to a normative group of sighted peers.

Methods of Data Collection and Analysis

Each subject was tested individually utilizing the Piagetian Battery of Reasoning Assessments, Short Form A, specifically adapted for the visually impaired (Stephens, 1977). A rating one - Concept Absent; two - Concept Transitional; or three - Concept Achieved was assigned to each of the following reasoning tasks: Classification (three measures); Conservation (three measures); Spatial Relations/ Mental Imagery (two

measures); and Formal Operations (three measures). Age norms for expected attainment for each of the tasks were derived from previous studies of Piagetian Development (Formanek & Gurian, 1976; Stephens & Simpkins, 1974). For each subtest, and for each of the four categories of subtests, a two-way contingency table was constructed using age in years by score. Analysis of the results was accomplished by comparing the average age mastery level of each task with the age norms presented by Stephens (1979) and Formanek & Gurian (1976) for each task. Since the data were essentially descriptive by age group, a statistical test of significance was not applied.

Results

For each concrete and formal operational task, a chronological age of expected achievement was derived from the available research. In cases where conflicting ages were reported, the higher CA expectancy was used. The results are summarized on Tables Nine and Ten.

Of the 33 subjects who were age 11.0 or older, only four had mastery of concrete operations. The remaining 29 were in transition on concrete operational tasks. In the area of formal operations, five of the 30 subjects with a CA of 12.0, or above, exhibited mastery; 18 were rated in transition and 4 were rated as absent on these tasks. Those categories of tasks which exhibited relatively poorer attainment for subjects with CA's $\geq$ 11 were ordered as follows: Classification, 48 percent attainment, Conservation, 45 percent attainment, and Spatial Relations, 27 percent attainment. The area of poorest performance in the 11 plus age group was Spatial Relations (at the concrete level) suggesting that the curtailing influence of diminished vision has its greatest effect on those cognitive processes which involve the manipulation of objects and ideas exterior to an egocentric sensory world.

Discussion: Patterns of Cognitive Development

The wide intertest scatter of the Wechsler subtest scores reveals a pattern of cognitive imbalances commonly exhibited by learning disabled individuals. Moreover, the overall measured IQ values for the population represented a broad range between Mentally Defective and Very Superior, results which clearly support one of the central assumptions of the present research, that visually impaired students cannot be classified as a homogeneous population with respect to curriculum development, educational planning or the prescription of remedial or habilitative activities. Indeed, these results pertinently reflect the necessity for including measures of neurological organization, measures of perceptual-motor and cognitive functioning and an evaluation of visual acuity among the criteria that are used both in making decisions regarding educational placement and in the development of I.E.P.'s. For educational purposes, a measure of visual acuity for distance is necessary, but not sufficient information. A diagnosed congenital visual impairment may or may not be the primary disabling or handicapping condition. Since other variables among the visually impaired have obvious and critical educational implications, assumptions underlying traditionally prescribed instructional activities for this population must be challenged. For example, this heterogeneous group, with a broad range of differential cognitive strengths and weaknesses, cannot have its varied educational needs adequately met with a curriculum developed on the assumption of population homogeneity. This issue is discussed in more detail in Part III-C of this research report.

The relatively elevated average scaled scores on the Similarities and Block Design subtests were unexpected results for a visually impaired population. However, an examination of the activities required in responding to these two subtests, along with an analysis of the related cognitive functions involved, suggest some provocative explanatory hypotheses.

The Similarities subtest requires the respondent to aurally perceive information which must be transformed and verbally expressed as a classificatory relationship. Initial items on this subtest are generally familiar and are likely to elicit previously overlearned associations. The items become incrementally more difficult and require the respondent to display a capacity for forming conceptual judgments. It is important to note that the progressive difficulty of the items emphasizes concept formation and does not involve increased word difficulty. In fact, the correlation of Similarities with verbal comprehension is very low and accounts for only 10% of the variance for the younger population (Cohen, 1957). The tasks on the Similarities subtest seem to represent abilities to abstract, to generalize and to discover relationships that are not immediately obvious. These cognitive processes involve essential components of visual imagery and an examination of the imagery in order to derive a concept formation from apparently unrelated objects or ideas, especially on the later items on the subtest where learned associations are usually not operant. The reasoning processes involved are abstract in the sense that the respondent is required to verbalize a problem solution for which there is no apparent practical application. Similarities is, therefore, considered to be a good measure of abstract verbal reasoning ability and a good

measure of general intelligence. Performance on other Verbal subtests, such as Comprehension, which emphasizes social norms and values and Information, which is significantly influenced by educational and cultural experiences, would seem to be more critically affected by past visual experiences. It could be hypothesized that the actual intellectual potential of the sample population is higher than the average Verbal, Performance, and Full-Scale Wechsler scores suggest. The effects of a congenital visual impairment on developmental acquisitions, along with related differential patterns of neurological organization, could be reflected not only in academic achievement levels, which are below expectations, but in measured cognitive imbalances as well.

The Block Design subtest requires the respondent to visually perceive and understand spatial relations as they are presented in a series of stationary design pattern stimuli. Additionally, the respondent is required to replicate the design pattern with red and white blocks. The principal cognitive activity involved is nonverbal reasoning rather than memory. The subtest also measures visual/motor coordination and integration. Both the Block Design and Similarities subtests are considered to be excellent measures of general intelligence.

Unlike the demands of the Object Assembly subtest where the subject is required to conceptualize a whole configuration by observing its various parts, the Block Design subtest requires only that the respondent replicate the stimulus design using interchangeable parts. Obviously, these two subtests are measuring different aspects of visual/motor skills and perceptual organization. On the Object Assembly subtest noninterchangeable parts must be organized manually into a whole configuration, with a minimum provision of clues on the WISC-R

and with no clues provided on the WAIS, with respect to the assembly goal; again, the Block Design tasks involve the replication of an accurately perceived stimulus configuration which does not include fine details. The Picture Arrangement subtest requires a good alertness to social cues as well as good visual acuity for details, requirements that could negatively affect the performances of the partially sighted. The Picture Completion subtest to a certain extent involves past visual experiences in that the respondent must visually identify missing details in sketches of a variety of somewhat familiar cultural figures. The Coding/Digit Symbol subtests involve visual/motor dexterity and accuracy for fine detail as well as visual memory skills. Among the Performance subtests, Block Design might be the best measure of nonverbal reasoning and analytic thinking abilities. The elevated average scaled score on the Block Design subtest for the sighted, visually impaired sample in this study yields additional evidence of greater intellectual potential than the Wechsler Verbal, Performance, and Full-Scale Scores indicate. It is important to consider, however, that the Block Design subtest is sensitive to the influences of previous learning. All the subjects in the present study had been exposed to intensive psychomotor and visual/motor educational activities, which included the manipulation of block materials in learning tasks similar to those presented on Block Design. A common familiarity with block construction tasks could, of course, have created a positive learning set and learning transference with respect to the demands of the Wechsler Block Design subtest.

Although data derived from the Piagetian Assessment were not amenable to traditional parametric statistical analyses, definite performance trends were evident from a descriptive analysis. The sample

selected for the present study did not exhibit cognitive developmental deficits as severe as those reported by Stephens (1974). Despite the finding that only four adolescent subjects demonstrated mastery of concrete operations, an analysis of the performances on individual tasks revealed that a majority of the adolescents had achieved, or were in transition, on the various sub-skills. Only five subjects of the 12-plus age group exhibited mastery of formal operations. These data clearly indicated that the majority of the adolescent subjects in the sample were in transition in the areas of concrete and formal operational thought and that mastery of concrete operations is extended through the adolescent stage and into early adulthood. When these results were evaluated along with the results of other assessments of cognitive functioning employed in this study, it was concluded that delays in cognitive development could not be exclusively, nor even predominantly, attributed to a reduction in distance visual acuity. The overall configuration of data derived from the various cognitive assessments strongly supports the assumption that a general deficit may be observed in perceptual motor functional intelligence. There is a definite indication that delays in the development of reasoning and general problem-solving abilities may represent underlying neuropsychological processes which are in turn developmentally affected by the visual system.

As a result of a comparison of the results of the Piagetian Assessment with the other three measures of abstract cognitive development, a tentative functional hierarchy was postulated. While performances on the Wechsler Similarities and Block Design subtests were relative areas of strength and performance on the Piagetian Tasks indicated a moderate developmental lag, the results of the Reitan Category

Test showed a significant delay (p=.05). The Category Test is a sensitive measure of general brain condition and assesses the ability to organize problem situations and to carry through with appropriate solutions to the perceived problems. The problems on the Category Test, which are relatively complex, are presented for visual reception. Whereas the Wechsler Block Design subtest requires that the subject learn one general principle for task solution, the Category Test requires the respondent to learn task-specific principles which may or may not apply logically to subsequent problem tasks. Additionally, the structure and length of the Category Test demands a more sustained focusing of visual attention than does the Block Design subtest.

For the total sample a factor analysis was performed on the eleven Wechsler subtest scores, the visual disability variable and the Halstead-Reitan Category Test. Three principal factors were extracted from the data: a Verbal Factor, which included all the Wechsler Verbal subtests, except Digit Span; a Performance Factor, which was defined by criterion loadings of all the Wechsler Performance subtests and the visual disability variable; and finally, an Attention/Distraction Factor, which comprised the Wecshler Arithmetic and Digit Span subtests and the Halstead-Reitan Category Test (See Table Sixteen). It is important to note that the Category Test is related to attentional deficits and does not load on with either the Verbal or Performance Factors.

A more detailed discusion of the results and implications of the factor analysis is provided in Section F below.

In general, the sample under study displayed the following hierarchial ordering of cognitive developmental strengths: the strongest area was abstract verbal reasoning ability as reflected in the

average scaled scores earned on the Wechsler Similarities subtest, followed by the ability to form nonverbal concepts and to perform replicative visual/motor activities, as evidenced by a relatively elevated average scaled score on Block Design. The sample was moderately weak on the Piagetian tasks which involve the solution of open-ended problems through the manipulation of materials and the application of inductive reasoning. Finally, the subjects in general performed quite poorly on problem tasks requiring logical analysis and abstract reasoning where sustained attention was also a requirement. This deficit was reflected in the significantly low average score earned on the Halstead-Reitan Category Test.

One of the most important conclusions derived from the results of this study was that the sighted, visually impaired subjects in the population sample exhibited developmentally inappropriate attention deficits. Attentional difficulties are frequently manifested by the learning disabled.

	$\bar{X}$ Verbal IQ	SD	Q_1	Q_2	Q_3	R
Legally Blind	97.3	21.2	78.75	96.33	113.25	62 - 136
Partially Seeing	91.3	14.5	81.0	92.0	99.75	69 - 122
Full Sample	93.7	17.6	79.25	95.75	105.75	62 - 136

	$\bar{X}$ Performance IQ	SD	Q_1	Q_2	Q_3	R
Legally Blind	80.2	17.9	71.63	75.00	92.25	48 - 115
Partially Seeing	89.3	17.0	81.67	87.50	98.00	55 - 121
Full Sample	85.5	17.8	73.42	85.00	94.75	48 - 121

Difference Between VIQ and PIQ (VIQ-PIQ)

	$\bar{X}$	SD	Q_1	Q_2	Q_3	R
Legally Blind	17.1	14.3	9.58	14.00	22.25	(-3) - 63
Partially Seeing	1.96	16.1	(-13.25)	7.00	13.25	(-25) - 33
Full Sample	8.19	17.0	0.25	9.88	16.13	(-25) - 63

	$\bar{X}$ FSIQ	SD	Q_1	Q_2	Q_3	R
Legally Blind	88.76	20.3	72.13	87.00	101.42	51 - 123
Partially Seeing	89.6	14.5	78.25	90.50	102.75	59 - 121
Full Sample	89.25	16.9	77.25	88.00	102.63	51 - 123

TABLE 3

Summary of WISC/WAIS Data Related to Box and Whisker Plots, Figures 1 through 4

FIGURE 1
Box and Whisker Plots of WISC-R and WAIS VIQ'S Expressed in
Quartiles for the Total Sample, Legally Blind, and Partially Seeing

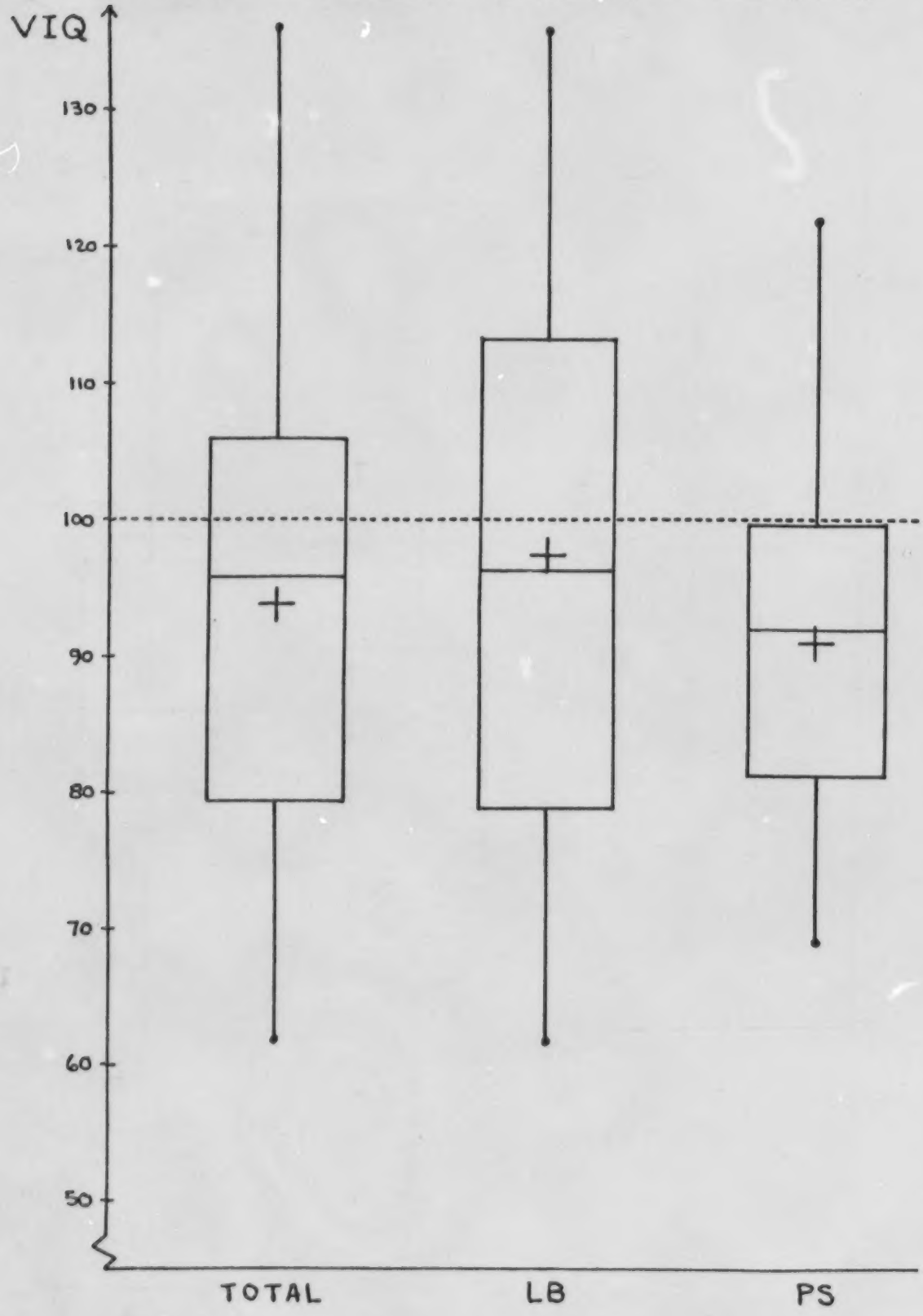


FIGURE 2
Box and Whisker Plots of WISC-R and WAIS Performance IQ'S Expressed in quartiles for the Legally Blind, Partially Seeing, and Full Sample.

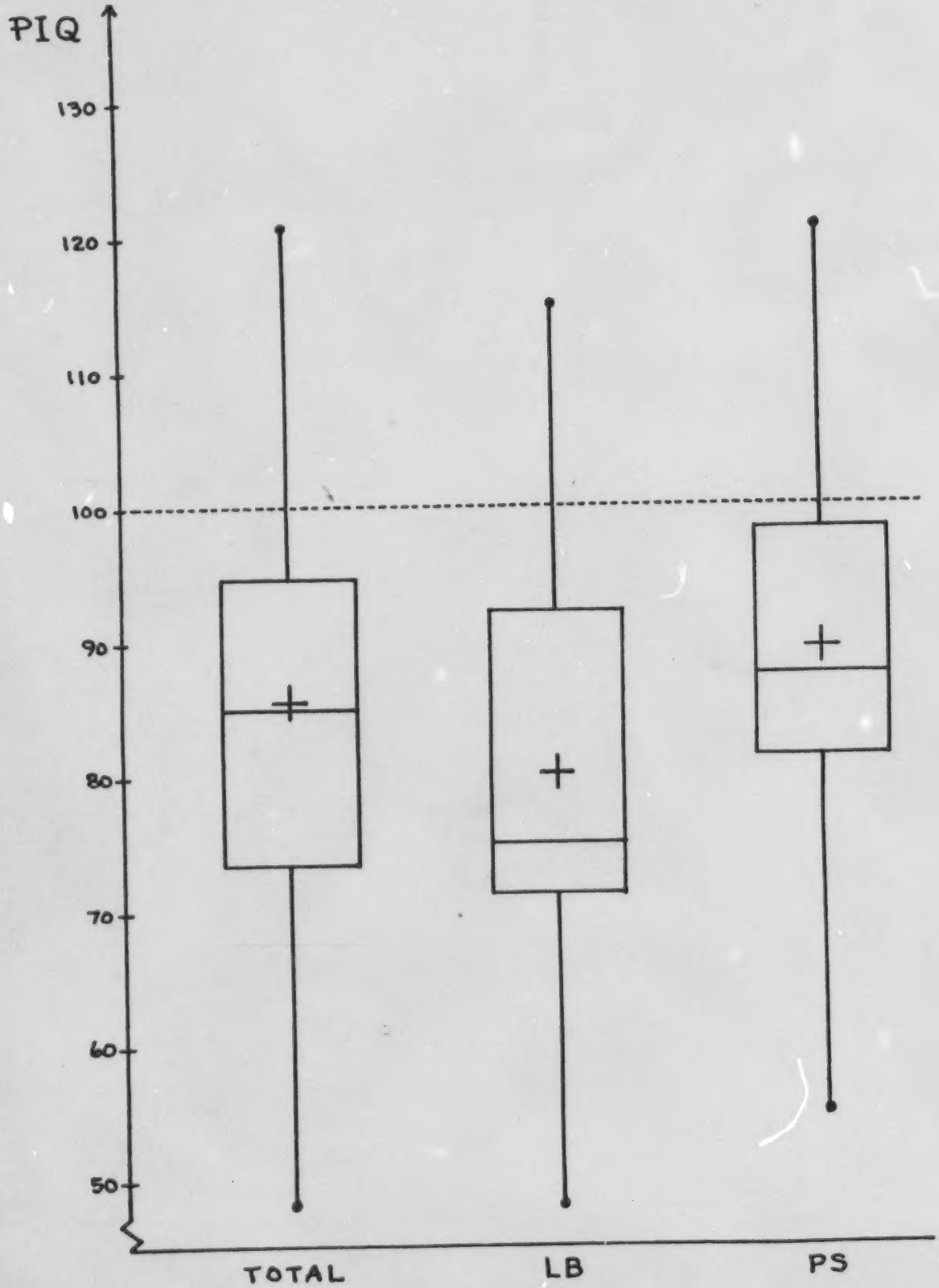


FIGURE 3
Box and Whisker Plots of WISC-R and WAIS FS IQ's Expressed in Quartiles for Legally Blind, Partially Seeing, and Full Sample

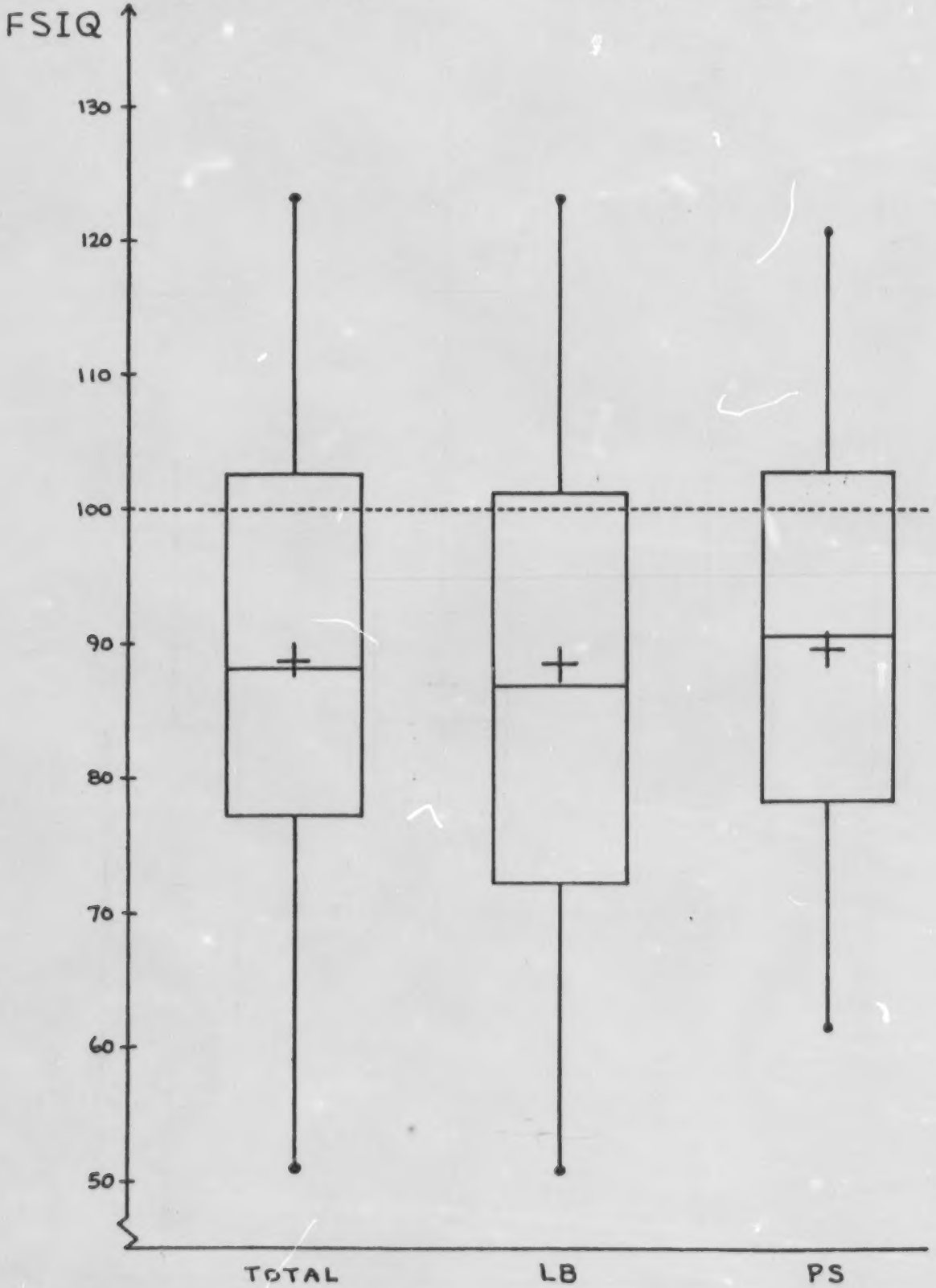


FIGURE 4
Box and Whisker Plots of Difference Between VIQ and PIQ Expressed in Quartiles for Legally Blind, Partially Seeing, and Full Sample

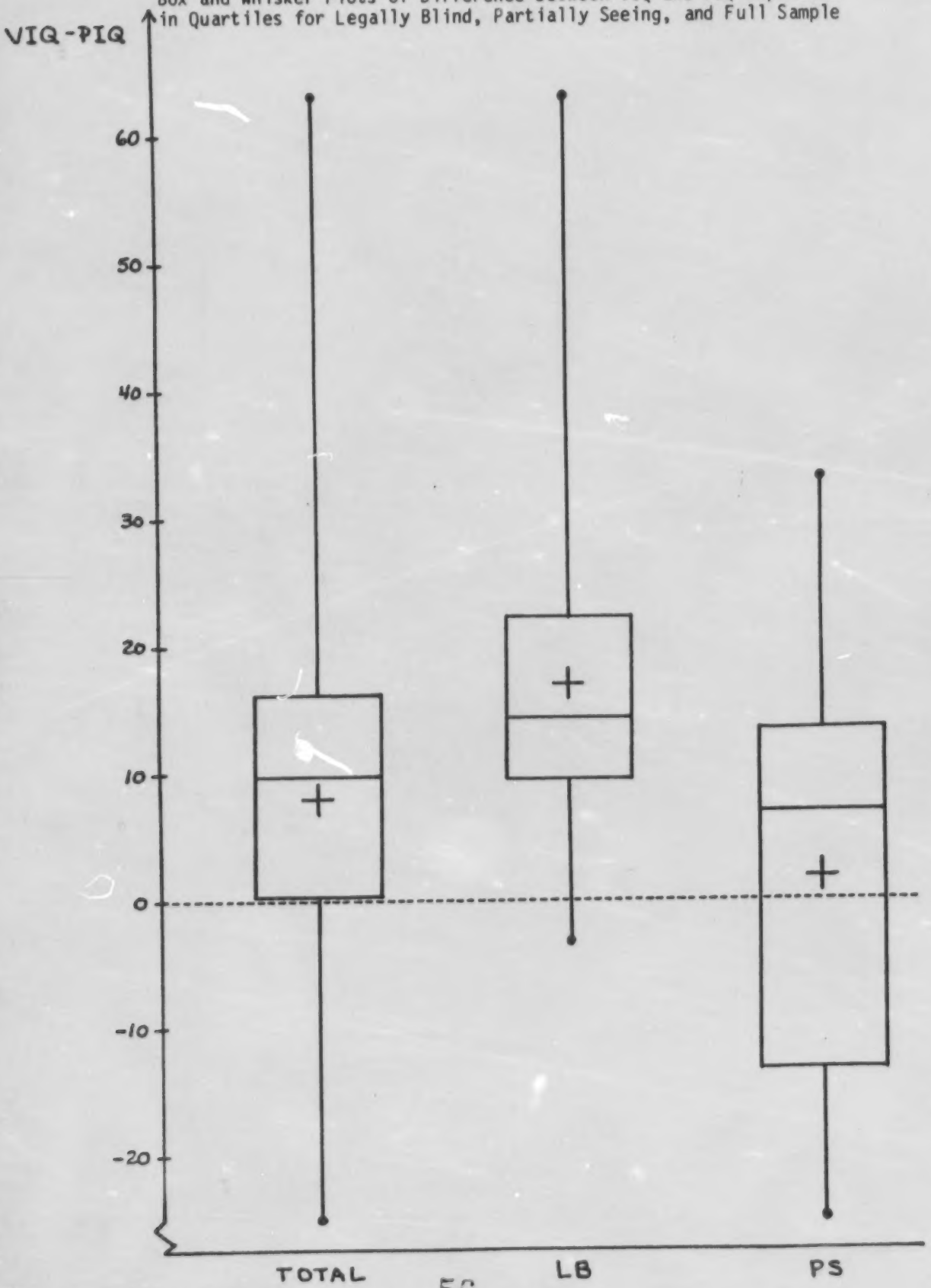


TABLE 4

WISC-R/WAIS Data for
Box-and-Whisker Plots, Figure 5

Subtest	$\bar{X}$	SD	Q_1	Q_2	Q_3	R
Information	8.49	3.10	6.29	8.33	10.75	2.00 - 15.00
Similarities	9.54	3.15	6.85	9.40	12.04	4.00 - 15.00
Arithmetic	8.90	3.02	6.63	8.42	10.75	3.00 - 16.00
Vocabulary	8.54	3.34	5.94	8.75	10.81	1.00 - 16.00
Comprehension	8.74	3.68	5.98	8.57	11.31	3.00 - 19.00
Digit Span	8.66	2.95	6.44	8.07	10.58	3.00 - 19.00
Picture Completion	7.66	3.07	5.69	7.75	9.25	1.00 - 16.00
Picture Arrangement	7.84	3.27	5.78	7.81	9.41	1.00 - 16.00
Block Design	9.35	3.62	7.25	9.28	11.35	1.00 - 18.00
Object Assembly	7.49	3.06	5.04	7.58	9.82	1.00 - 15.00
Coding/Digit Symbol	6.76	3.52	4.19	6.41	9.31	1.00 - 14.00

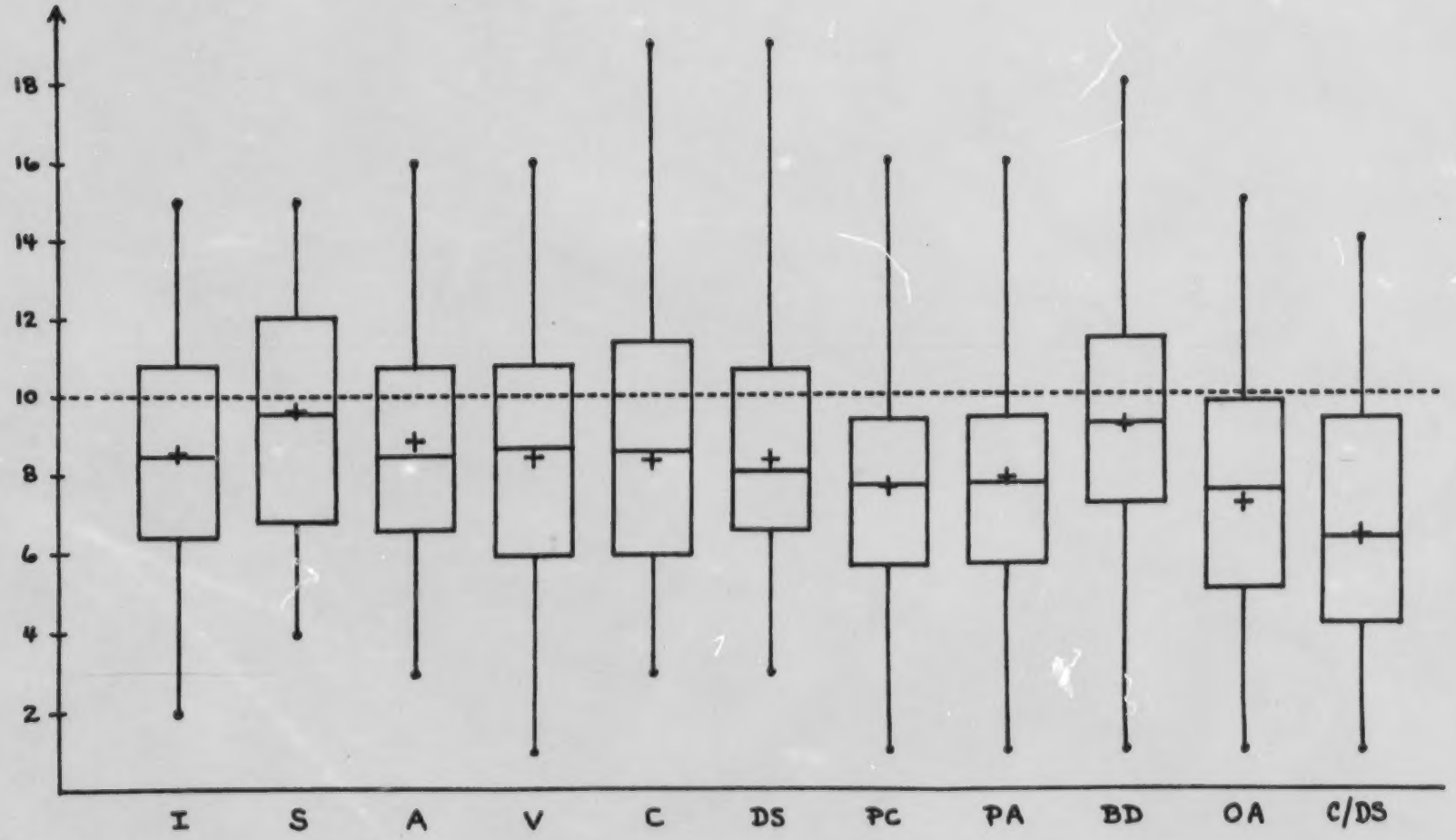


FIGURE 5

Box and Whisker Plots of Average Scaled Scores on the WISC-R/WAIS for the Total Sample

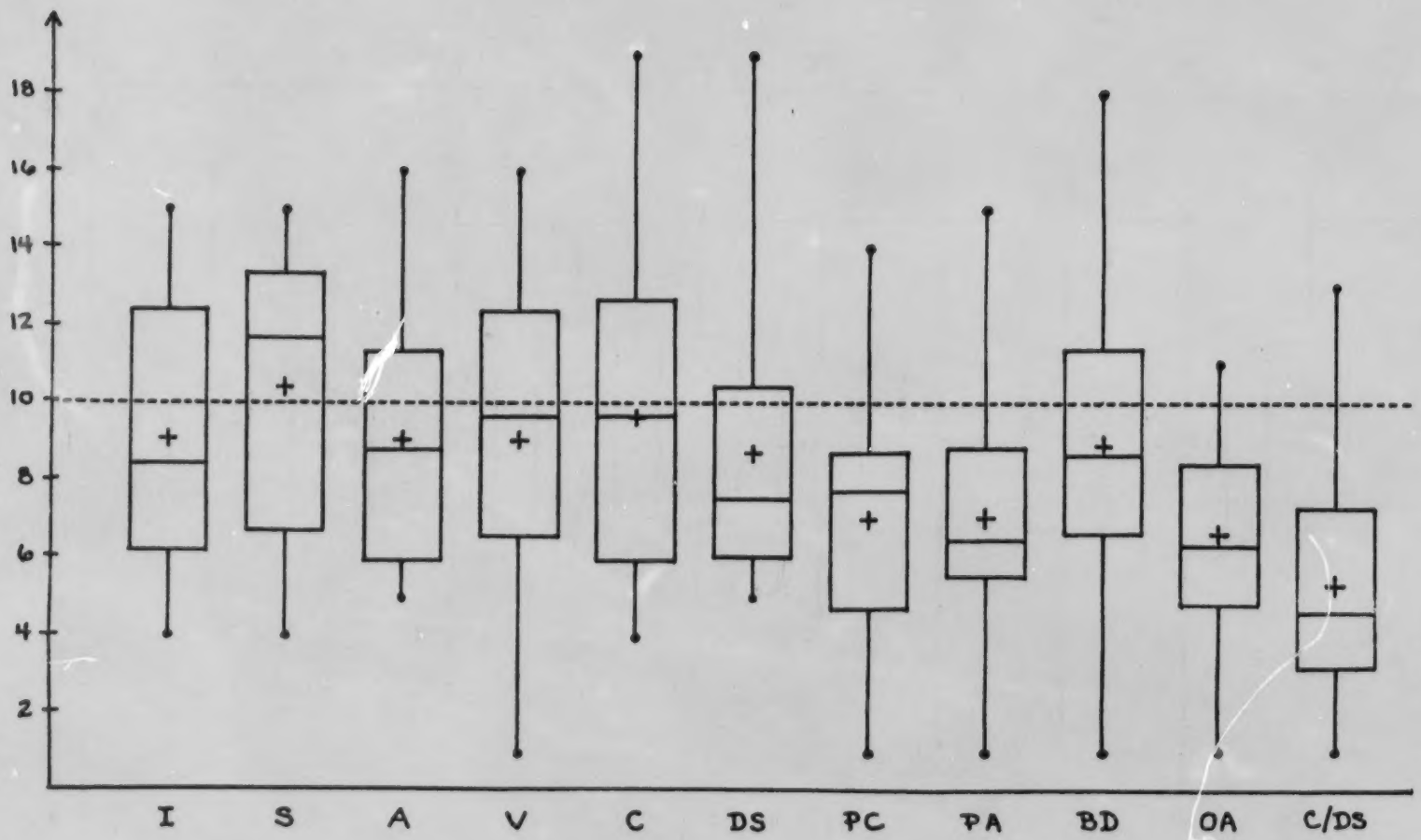
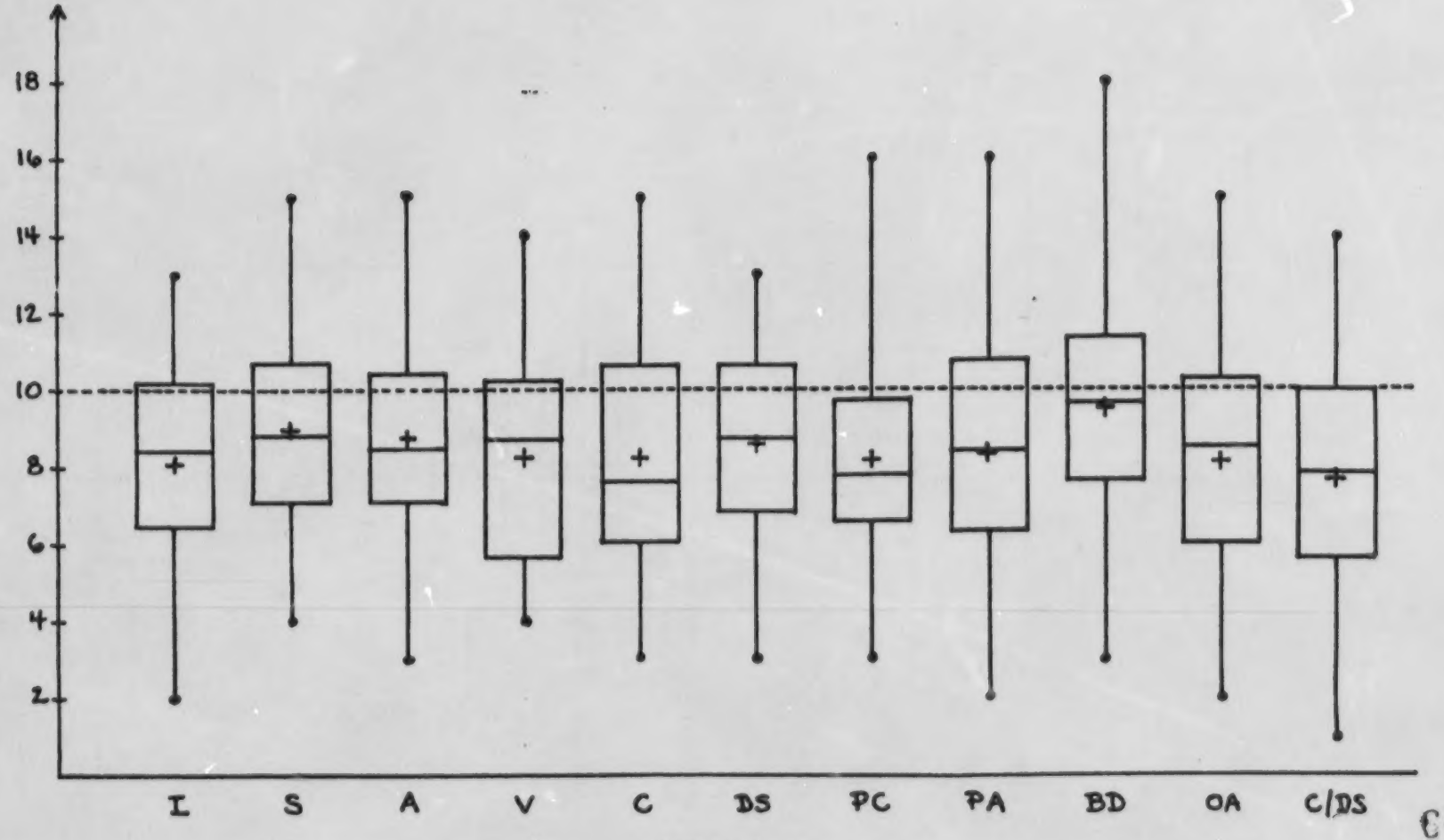


FIGURE 6

Box and Whisker Plots of WISC-R/WAIS Subtest Scaled Scores, Legally Blind Sample



62

FIGURE 7

Box and Whisker Plots of WISC-R/WAIS Subtest Scaled Scores, Partially Sighted

TABLE 5

WISC Scatter Analysis
N = 42

Top Number = Number of Subjects for Which Row Score - Column Score GE +3(WISC) or +5(WAIS)
Bottom Number = Top Number Converted to a Percentage

WISC	INFOR	SIMIL	ARITH	VOCAB	COMPR	DGT-S	P-COM	P-ARR	B-DES	OBJ-A	C/DS
INFOR	0	4	6	8	6	11	15	11	9	12	20
	0.0	9.5	14.3	19.0	14.3	26.2	35.7	26.2	21.4	28.6	47.6
SIMIL	12	0	9	11	12	13	21	18	15	19	22
	28.6	0.0	21.4	26.2	28.6	31.0	50.0	42.9	35.7	45.2	52.4
ARITH	10	2	0	9	10	10	16	13	10	13	21
	23.8	4.8	0.0	21.4	23.8	23.8	38.1	31.0	23.8	31.0	50.0
VOCAB	7	1	3	0	5	11	16	13	6	12	18
	16.7	2.4	7.1	0.0	11.9	26.2	38.1	31.0	14.3	28.6	42.9
COMPR	8	4	9	6	0	13	16	15	13	14	20
	19.0	9.5	21.4	14.3	0.0	31.0	38.1	35.7	31.0	33.3	47.6
DGT-S	9	7	7	11	8	0	13	8	9	12	14
	21.4	16.7	16.7	26.2	19.0	0.0	31.0	19.0	21.4	28.6	33.3
P-COM	8	3	4	10	8	4	0	5	4	7	13
	19.0	7.1	9.5	23.8	19.0	9.5	0.0	11.9	9.5	16.7	31.0
P-ARR	7	5	5	9	8	5	10	0	6	11	13
	16.7	11.9	11.9	21.4	19.0	11.9	23.8	0.0	14.3	26.2	31.0
B-DES	12	9	9	13	12	11	18	11	0	13	21
	28.6	21.4	21.4	31.0	28.6	26.2	42.9	26.2	0.0	31.0	50.0
OBJ-A	5	4	4	8	7	7	5	6	2	0	14
	11.9	9.5	9.5	19.0	16.7	16.7	11.9	14.3	4.8	0.0	33.3
C/DS	6	3	4	7	7	3	6	4	5	7	0
	14.3	7.1	9.5	16.7	16.7	7.1	14.3	9.5	11.9	16.7	0.0

Similarities vs. Vocabulary: Similarities higher in 26%

Over 25% were higher in Similarities than Information, Vocabulary, and Comprehension: Similar Results for Block Design

TABLE 6

WAIS Scatter Analysis
N = 8

Top Number = Number of Subjects for Which Row Score - Column Score GE +3(WISC) or +5(WAIS)
Bottom Number = Top Number Converted to a Percentage

WISC	INFOR	SIMIL	ARITH	VOCAB	COMPR	DGT-S	P-COM	P-ARR	B-DES	OBJ-A	C/DS
INFOR	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	1 11.1
SIMIL	1 11.1	0 0.0	2 22.2	0 0.0	2 22.2	0 0.0	1 11.1	2 22.2	0 0.0	2 22.2	2 22.2
ARITH	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	1 11.1	0 0.0	2 22.2	1 11.1
VOCAB	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	1 11.1	0 0.0	2 22.2	2 22.2
COMPR	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	1 11.1
DGT-S	0 0.0	1 11.1	0 0.0	1 11.1	0 0.0	0 0.0	0 0.0	3 33.3	0 0.0	2 22.2	3 33.3
P-COM	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	1 11.1
P-ARR	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0
B-DES	2 22.2	2 22.2	3 33.3	2 22.2	1 11.1	2 22.2	1 11.1	3 33.3	0 0.0	4 44.4	2 22.2
OBJ-A	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	1 11.1	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0
C/DS	1 11.1	2 22.2	0 0.0	2 22.2	1 11.1	0 0.0	0 0.0	0 0.0	0 0.0	2 22.2	0 0.0

TABLE 7

Scatter Analysis of WISC-R/WAIS Subtest Data

Top Number = Number of Subjects for Which Row Score Minus Column Score is Greater than or Equal to 3(WISC-R) or 5(WAIS)
Bottom Number = Top Number Converted to a Percentage

SUBTEST	INFOR	SIMIL	ARITH	VOCAB	COMPR	DGT-S	P-COM	P-ARR	B-DES	OBJ-A	C/DS
INFOR	0	4	6	8	6	11	15	11	9	12	21
	0.0	7.8	11.8	15.7	11.8	21.6	29.4	21.6	17.6	23.5	41.2
SIMIL	13	0	11	11	14	13	22	20	15	21	24
	25.5	0.0	21.6	21.6	27.5	25.5	43.1	39.2	29.4	41.2	47.1
ARITH	10	2	0	9	10	10	16	14	10	15	22
	19.6	3.9	0.0	17.6	19.6	19.6	31.4	27.5	19.6	29.4	43.1
VOCAB	7	1	3	0	5	11	16	14	6	14	20
	13.7	2.0	5.9	0.0	9.8	21.6	31.4	27.5	11.8	27.5	39.2
COMPR	8	4	9	6	0	13	16	15	13	14	21
	15.7	7.8	17.6	11.8	0.0	25.5	31.4	29.4	25.5	27.5	41.2
DGT-S	9	8	7	12	8	0	13	11	9	14	17
	17.6	15.7	13.7	23.5	15.7	0.0	25.5	21.6	17.6	27.5	33.3
P-COM	8	3	4	10	8	4	0	5	4	7	14
	15.7	5.9	7.8	19.6	15.7	7.8	0.0	9.8	7.8	13.7	27.5
P-ARR	7	5	5	9	8	5	10	0	6	11	13
	13.7	9.8	9.8	17.6	15.7	9.8	19.6	0.0	11.8	21.6	25.5
B-DES	14	11	12	15	13	13	19	14	0	17	23
	27.5	21.6	23.5	29.4	25.5	25.5	37.3	27.5	0.0	33.3	45.1
OBJ-A	5	4	4	8	7	8	5	6	2	0	14
	9.8	7.8	7.8	15.7	13.7	15.7	9.8	11.8	3.9	0.0	27.5
C/DS	7	5	4	9	8	3	6	4	5	9	0
	13.7	9.8	7.8	17.6	15.7	5.9	11.8	7.8	9.8	17.6	0.0

TABLE 8

Frequency and Percentage of Sample Exhibiting Significant Scatter on the Verbal and Performance Scales of the WISC-R/WAIS

WISC:	VIQ-PIQ LE -12	NUMBER = 7	PERCENTAGE = 16.7
	VIQ-PIQ GE 12	NUMBER = 19	PERCENTAGE = 45.2
		TOTAL = 26	PERCENTAGE = 61.9
WAIS:	VIQ-PIQ LE -20	NUMBER = 0	PERCENTAGE = 0.0
	VIQ-PIQ GE 20	NUMBER = 1	PERCENTAGE = 11.1
		TOTAL = 1	PERCENTAGE = 11.1
BOTH SCALES:	NEG. DIFF.	NUMBER = 7	PERCENTAGE = 13.7
	POS. DIFF.	NUMBER = 20	PERCENTAGE = 39.2
		TOTAL = 27	PERCENTAGE = 52.9

TABLE 9

Task Analysis of Piagetian Attainment in Relation to Mean Age of Mastery Derived from Stephens (1979) and Formanek and Gurian (1976)

Category	Task	CA - Expected Attainment	Percentage of Ss exhibiting mastery at or above expected CA: Absent or Transition	Achieved	Summary - All Tasks
Concrete Operations					
Conservation	Term-to-Term Correspondence	8.0	9%	91%	Mastery of Conservation* for Subjects with a CA $\geq$ 11: 45%
	Conservation of Substance	8.0	28%	72%	
	Conservation of Volume	8.0	59%	41%	Mastery of Conservation Total Sample: 17%
Spatial Relations/ Mental Imagery	Rotation/ Order of Beads	8.0	43%	57%	Mastery of Spatial Relations for Subjects with a CA > 11: 27%
	Rotation/ Square	10.0	61%	39%	Mastery of Spatial Relations/ Total Sample: 10%
Classification	Foods	10.0	41%	59%	Mastery of Classification for Subjects with a CA $\geq$ 11: 48%
	Changing Criterion	9.0	30%	70%	
	Class Inclusion/ Beads	10.0	44%	56%	Mastery of Classification/ Total Sample: 19%
Formal Operations					
	Conservation of Volume	$\geq$ 12	73%	27%	Mastery of Formal Where CA = $\geq$ 12: 17%
	Classification/Foods	$\geq$ 12	40%	60%	Mastery of Formal/ Total Sample: 10%
	Combinatory Logic	$\geq$ 12	60%	40%	

*Mastery of any operation was defined by an "achieved" rating on all subtests related to that specific operation.

TABLE 10

Results of Assessment of Concrete Operations
for Subjects with a CA $\geq$ 11 (N = 33)

	Absent	Transition	Achieved
No.	0	29	4
%	0%	88%	12%

Results of Assessment of Formal Operations
for Subjects with a CA $\geq$ 12 (N = 30)

	Absent	Transition	Achieved
No.	4	18	5
%	13%	60%	17%

B. Patterns of Psychomotor Development

Hypothesis 2.0

> Sighted, visually impaired children demonstrate a significant lag in gross motor, fine-motor and visual-motor development as measured by the Halstead-Reitan Neuropsychological Battery when compared to the standardization group of sighted peers.

Method of Data Collection and Analysis

Gross motor ability was defined as performance on the Tactual Performance Test. Fine-motor ability was defined as the subjects' performance on the Finger Oscillation Test. Visual-Motor development was defined as the subjects' performance on the Block Design, Object Assembly and Coding/Digit Symbol subtests of the WISC-R/WAIS and the Bender Visual-Motor Gestalt test. Analysis of gross and fine motor development was performed by calculating a one-tailed z-test using the standard scores from the Tactual Performance and Finger Oscillation Tests, respectively. Delays in visual-motor development were assessed with a one tailed z-test using standard scores of the WISC-R/WAIS subtests. Differences between the perceptual motor age and chronological age were computed for the Bender-Gestalt and analyzed descriptively. A ceiling of age 11.0 was used in computing deviation scores for the Bender-Gestalt as developmental age norms were not available for older subjects. A summative analysis (motoric development) was performed by calculating the proportion of the five tests on which each subject's observed z-score was below zero.

Results

The results are summarized on Table Eleven and Figures Eight and Nine. The visually impaired sample displayed significant motoric delays on four of the five variables ($p < 0.001$). The single measure of visual-motor ability which did not reflect a significant difference between the average obtained score and normative data was Block Design. Results of the Bender-Gestalt yielded an average delay of 2.63 years between chronological age and perceptual-motor age using the Koppitz (1963) method of scoring.

Hypothesis 2.1

> There is a significant positive correlation between a measured lag in motoric development and positive neurological indicators on the Halstead-Reitan.

Methods of Data Collection and Analysis

For the purpose of this hypothesis, motoric development was defined as subject's performance on The Block-Design, Object Assembly, and Coding/Digit Symbol subtests of the WISC-R and WAIS. The variable "positive neurological indicators" was defined differently for each age group, based on the current availability of normative data for the Halstead-Reitan Neuropsychological Battery. For the age group 9-14.11, Rules for Neuropsychological Diagnosis (Selz & Reitan, 1980) was applied to each subject's protocol to yield a summative score of total test functioning (Rules Analysis). For the age group 15 and older, the Impairment Index was calculated, expressed as the total number of tests on which the subject scored in the impairment range (N+). Correlations between the motor-subtest, Rules Analysis scores and Impairment Index (N+) scores were calculated.

Data for the four subjects below the age of nine were submitted to individual clinical analysis. As of this writing, a method for expressing total test performance on the Halstead-Reitan for subjects below nine years of age has not been developed.

Results

The null hypothesis was rejected at the .05 level of confidence. Results are presented in Table Twelve. Negative correlations between each of the motor and visual-motor subtests of the WISC-R and WAIS and total performance on the Halstead-Reitan were found, i.e., as scaled subtest scores increased, the positive neurological indicators (Rules Scores and Impairment Index Scores) decreased. Seven of the eight correlations were significant where $p < 0.05$. The single non- significant correlation was between Coding/Digit Symbol and the Rules Score for the 27 subjects in the 9-14.11 age group.

Discussion: Patterns of Psychomotor Development

Psychomotor development of a sample of sighted, visually impaired children was investigated with a battery of six instruments which assessed gross motor, fine motor and visual-motor development. Gross motor development was assessed using the Tactual Performance Subtest (TPT) of the Halstead-Reitan. In performing this task, the blindfolded subject was required to identify various shapes haptically and perceive the essential components of a problem situation. The data supported a significant deficit in this area and a significant relationship between performance on the TPT and overall neuropsychological functioning; that is, impaired performance on the TPT was associated with a greater number of signs of neuropsychological dysfunction.

A similar pattern was found in the Finger Oscillation Subtest which required the subject to sustain a purely motor task. The TPT and Finger Oscillation subtests tapped motor functions which did not require vision. The significantly impaired performance on these subtests and their significant correlation with neuropsychological functioning supported the researchers' assumption that neuropsychological functioning is an intervening variable in motoric functioning for the visually impaired.

Three subtests of the WISC-R/WAIS were used to investigate visual-motor development. The Block Design subtest was used to assess that aspect of visual-motor functioning which is essentially replicative. The task requires the subject to analyze a visual pattern and to reproduce it using blocks. Performance on this subtest was not significantly impaired but it was significantly related to overall neuropsychological functioning.

In contrast to Block Design which taps a visual-motor reproductive ability, the Object Assembly subtest assesses constructive ability which involves the coordination of visual analysis and visual synthesis with simple assembly tasks (Sattler, 1974). This subtest requires the subject to hypothesize a final outcome and assemble puzzle pieces into a meaningful figure. Performance on the Object Assembly subtest showed a significant deficit and was significantly correlated with overall neuropsychological functioning.

The Coding subtest of the WISC-R and the Digit Symbol subtest of the WAIS assessed the subjects' visual-motor coordination and speed via paper and pencil task. Performance on the Coding and Digit symbol subtests suggested that congenitally reduced vision is associated with

impaired perceptual-motor speed. Correlation with overall neuropsychological functioning was confirmed, but to a lesser degree than for the other subtests.

Analysis of these initial results generated research questions in addition to the stated hypothesis. For example, "Is the correlation between impaired visual-motor functioning more closely related to degrees of visual disability or overall neuropsychological functioning?" An additional analysis was performed to test for differences between the Pearson correlations of total motor score, visual acuity, Rules Analysis and N+ analysis. The results indicated that for the younger age group (9 - 14.11), motoric impairment was significantly correlated with both visual disability and neuropsychological functions ($p=.001$), with no significant difference between the two correlations. For the older subjects (15 and above) the difference between these correlations was significant at the .05 level. Degree of visual disability did not correlate significantly with motoric development. It was observed that with older subjects, the underlying neuropsychological processes, rather than degree of vision, are factors which affect motoric performance.

Assessment of psychomotor functioning undertaken in this study confirmed other research which found that school-aged, visually impaired students demonstrate significant deficits in motor and visual-motor development. Additional analyses supported the hypothesis that motoric delays are related to degree of visual disability for younger students, and neuropsychological functioning for all ages, confirming this factor as a significant intervening variable. The single visual-motor assessment which did not show significant impairment was performance on the Block-Design subtest which taps a replicative visual-motor skill.

TABLE 11

Results of Analysis of Motor Development Using One-Tailed z-Test

Test	Measure	z-Score	Level of Significance
Tactual Performance	Gross-Motor	-7.098	$p < .001$
Finger Oscillation	Fine-Motor	-4.542	$p < .001$
Block Design	Visual-Motor	-1.543	Ns
Object Assembly	Visual-Motor	-5.977	$p < .001$
Coding/Digit Symbol	Visual-Motor	-7.698	$p < .001$

FIGURE 8

Box and Whisker Plots of z-Score Results for
Motoric Development Tests, Total Sample

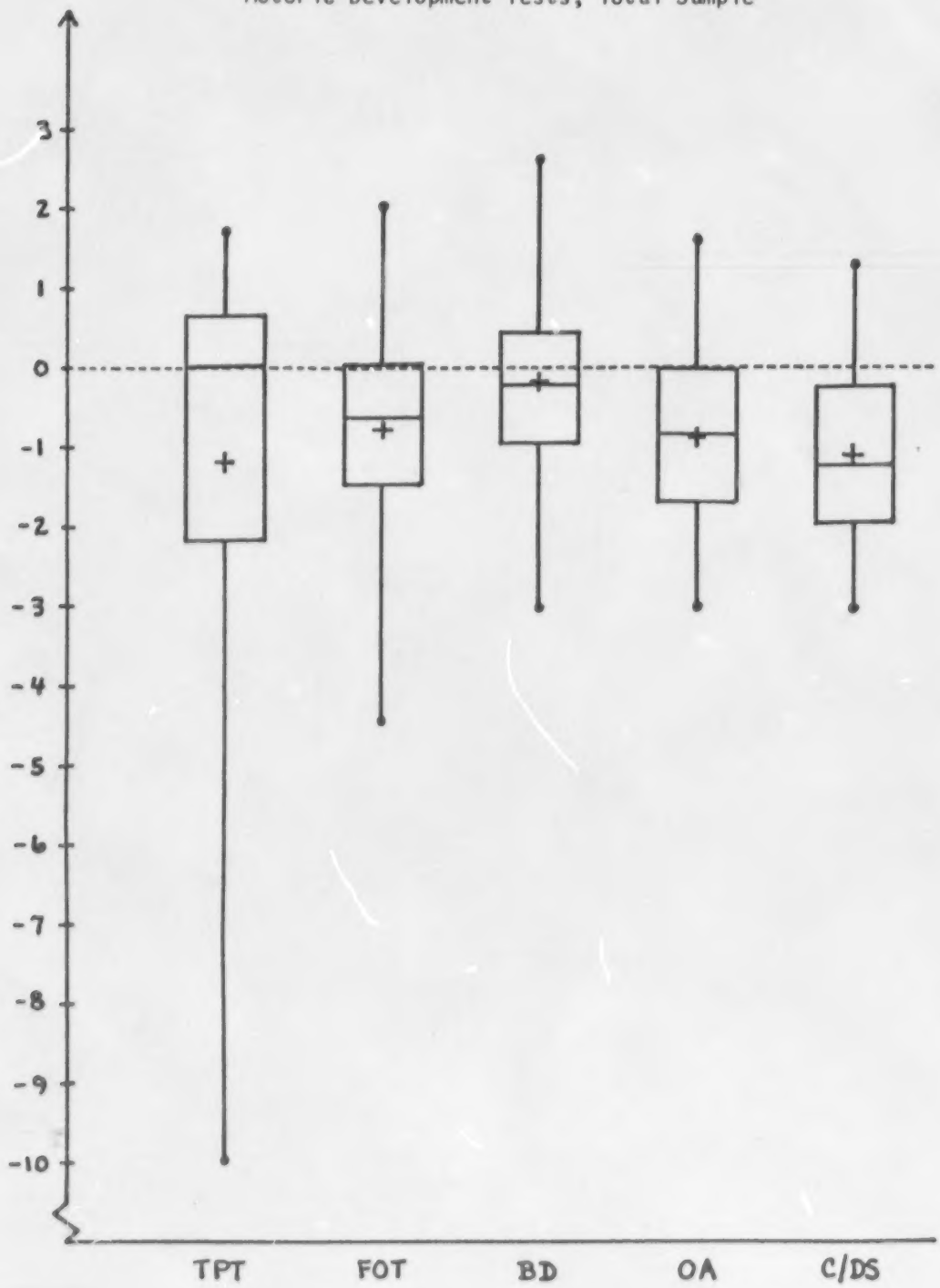


FIGURE 9

Box and Whisker Plot of Visual-Motor Delay in Years, Derived from the Bender-Gestalt (Chronological Age - Perceptual Motor Age where CA $\leq$ 11.0)

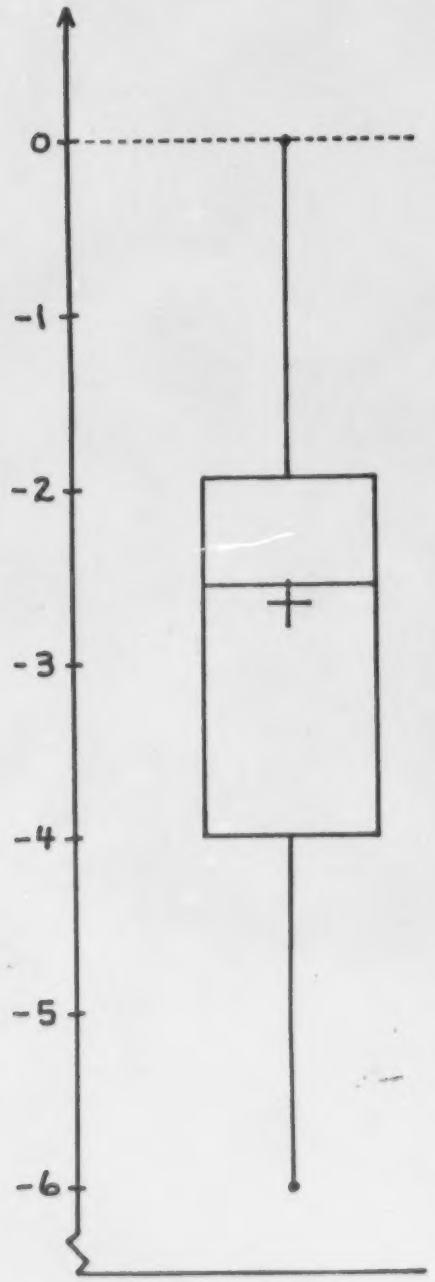


TABLE 12

Pearson Correlation Coefficients Between Visual-Motor Subtests of the WISC-R/WAIS and Neuropsychological Impairment

Motor Subtests	Rules	Level of Significance	N+	Level of Significance
Block Design	-0.5872	.001	-0.6476	.002
Object Assembly	-0.6652	.001	-0.6298	.003
Coding/Digit Symbol	-0.2368	.092*	-0.4996	.017
Total	-0.6098	.001	-0.6888	.001

*non-significant

C. Patterns of Academic Achievement

Hypothesis 3.0

Sighted visually impaired children demonstrate ability/achievement discrepancies in the areas of reading and mathematics as compared to a normative group of sighted peers. Reading achievement is on the average two years delayed. Math achievement is on the average one year delayed.

Methods of Data Collection and Analysis

Each subject was tested for reading achievement with the Wide Range Achievement Test and the Monroe Sherman Test of Reading Comprehension. Math Achievement was assessed by the Wide Range Achievement Test. Expectancy scores were calculated by comparing each subject's WISC/WAIS IQ with the standard score expectancy charts in the WRAT Manual, and calculating the difference between expected and obtained grade levels. A similar procedure was utilized for the Monroe Sherman Test using tables of local norms. Deviation scores were pooled and averaged. A one-tailed z-test was performed to test the null hypothesis for each of the three variables, reading decoding, reading comprehension and math computation, for the legally blind and partially seeing subsamples.

Results

Results are presented in Figures Ten through Twelve. Data analysis substantiated rejection of the null hypothesis for reading comprehension ($p < 0.001$) and math computation ($p < 0.011$). Reading decoding was not significantly delayed ($p = 0.240$). Similar results were found when data from the legally blind and partially seeing were analyzed separately.

The data supported other studies which documented that visually handicapped children function significantly below their capacity level

in academic subjects. A surprising finding was the observed lack of delay in visual reading decoding. Many of these same subjects were tested in 1975 (Daugherty, 1978) and were found to be an average of 2.17 years delayed in reading decoding skills. At that time, a new remedial program, the Monterey Reading Program, was adopted for the visually impaired. Data from the present study strongly suggest that this treatment contributed to the elevation of basic decoding skills, but apparently did not affect reading comprehension.

Discussion: Patterns of Academic Achievement

A review of available literature on the academic competence of the visually impaired suggests that these students are characterized by significant deficits in academic achievement. In this study, each child's Verbal IQ was used to establish an expected achievement level. The integrity of this approach is addressed in numerous reports and is generally viewed as a more clinically valid method than comparing a child to group data based on grade placement expectations.

Results of this investigation documented that visually impaired students demonstrate significant deficits in reading comprehension and math computation, results which corroborate similar findings by Birch et al. (1966) and Karnes (1963). It was also observed that reading decoding skills improved from a delay of 2.17 years to slightly less than one year in a four year period. This change was hypothesized to be associated with the implementation of a highly structured synthetic phonics program reported by Daugherty (1978).

This latter observation has important implications for educational intervention in programs for the visually impaired. If it can be demonstrated that academic achievement is responsive to intensive,

individualized teaching, it is suggested that this service should be addesssed both in teacher-training and direct-service models. Provision of specific academic remediation has not traditionally been considered the province of the teacher of the visually impaired. For example, a document prepared by the National Learning Resource Center of Pennsylvania (NLRCP) concerning the content of I.E.P.'s for the visually impaired (March, 1977) stated rather pointedly that:

> The curricular areas which might be the primary focus of an IEP for a visually handicapped student are presented in the Standards for the Operation of Special Education Programs and Services, section 10.6 (Pennsylvania Department of Education, 1976 Draft). The IEP may include but is not limited to documentation of instructional activities (for the partially sighted) in such areas as: vision stimulation, sight utilization, auditory training and listening skills development, orientation and mobility, typewriting, techniques of daily living and career education. (NLRCP, 1977, p. 3)

An analysis of this "vision curriculum" obviates a lack of any reference to academic tutoring or remediation. Apparently, the authors of the State Standards assumed that visually impaired children have deficts in auditory functioning, should learn by listening, and (for some undocumented reason) must be taught typewriting on a one-to-one basis.

No definitions are provided in this document for "vision stimulation" and "sight utilization." It is implied that students will be stimulated to become more efficient visual learners, but in relation to what is not specified. The document also states that:

> Unlike most handicapping conditions (e.g., mental retardation or learning disabilities) a visual impairment is based primarily on a diagnosed sensory deficiency rather than on the results from a psychological evaluation, or on a discrepancy between expected and actual educational achievement. (NLRCP, 1977, p. 3)

Even though the educational designation of "visually impaired" is derived from determination of sensory loss, it does not logically follow

that the prescribed educational program should address only those areas presumed to be affected by the sensory loss. This study clearly documented that academic underachievement is a significant variable associated with reduced vision. Section D further substantiates the relationship between academic achievement and the neuropsychological underpinnings of visual impairment.

FIGURE 10

Deviations Between MA Expectancy Score and
WRAT Reading/Total Sample

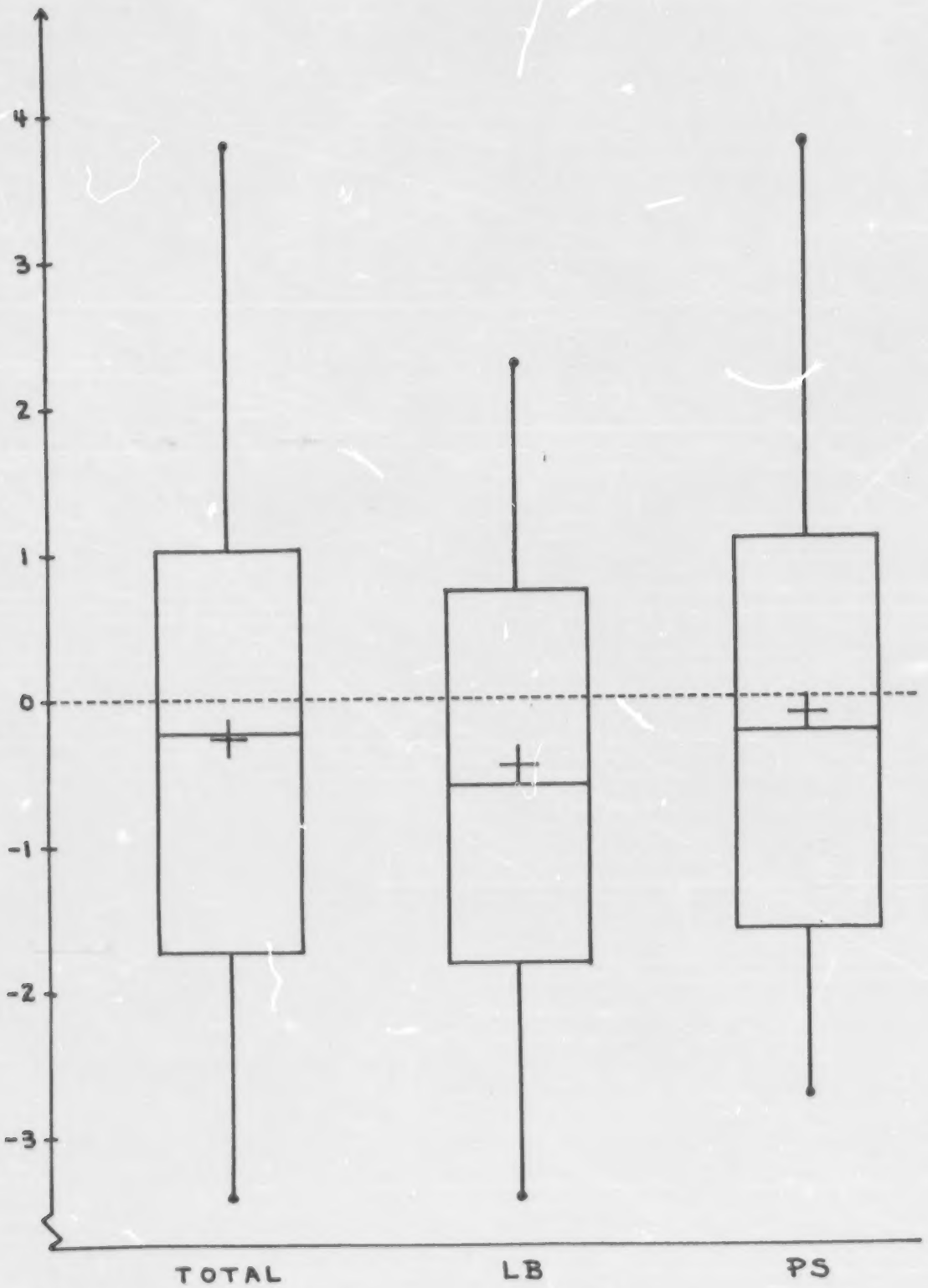


FIGURE 11

Deviations Between MA Expectancy Score and WRAT Math

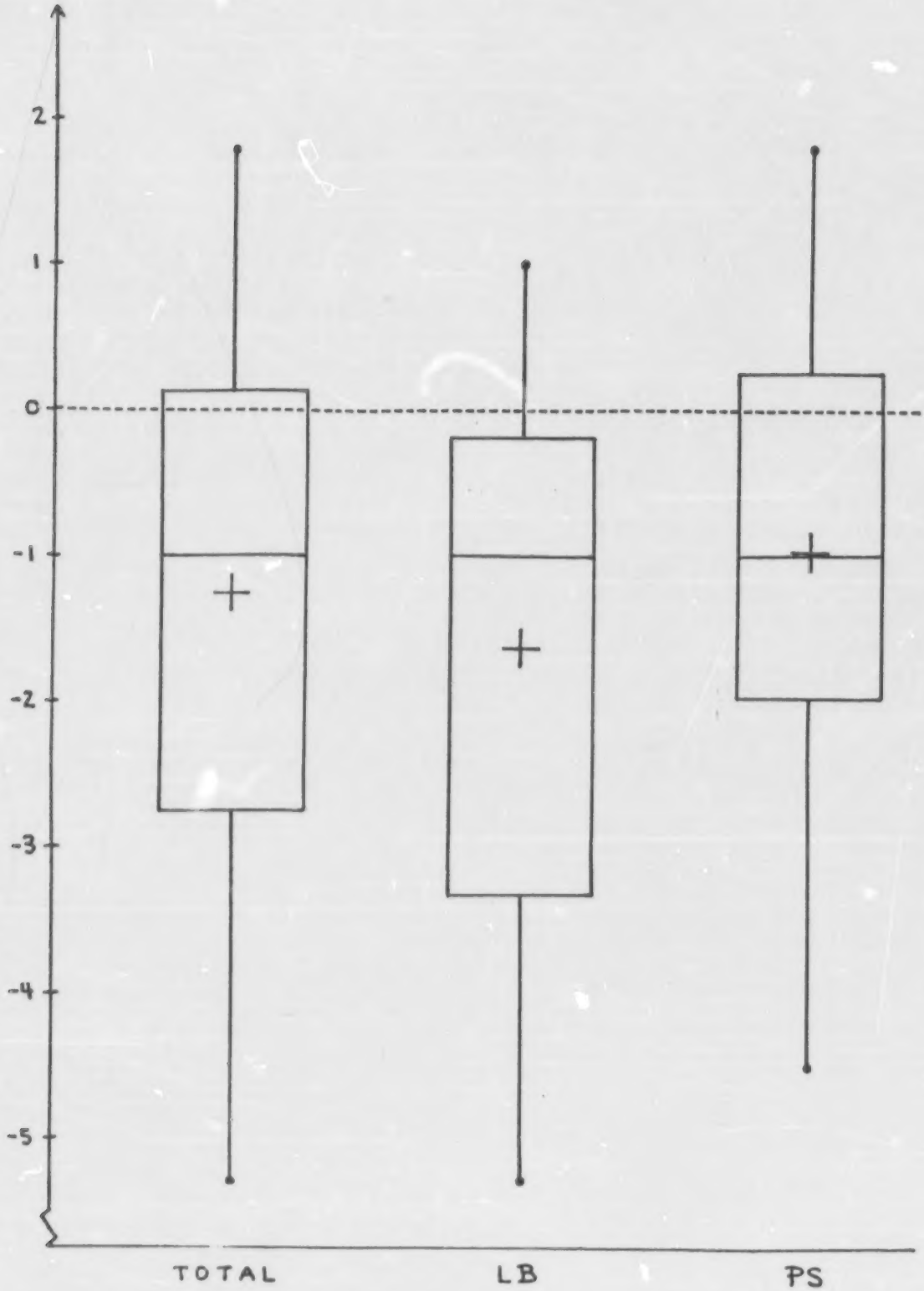
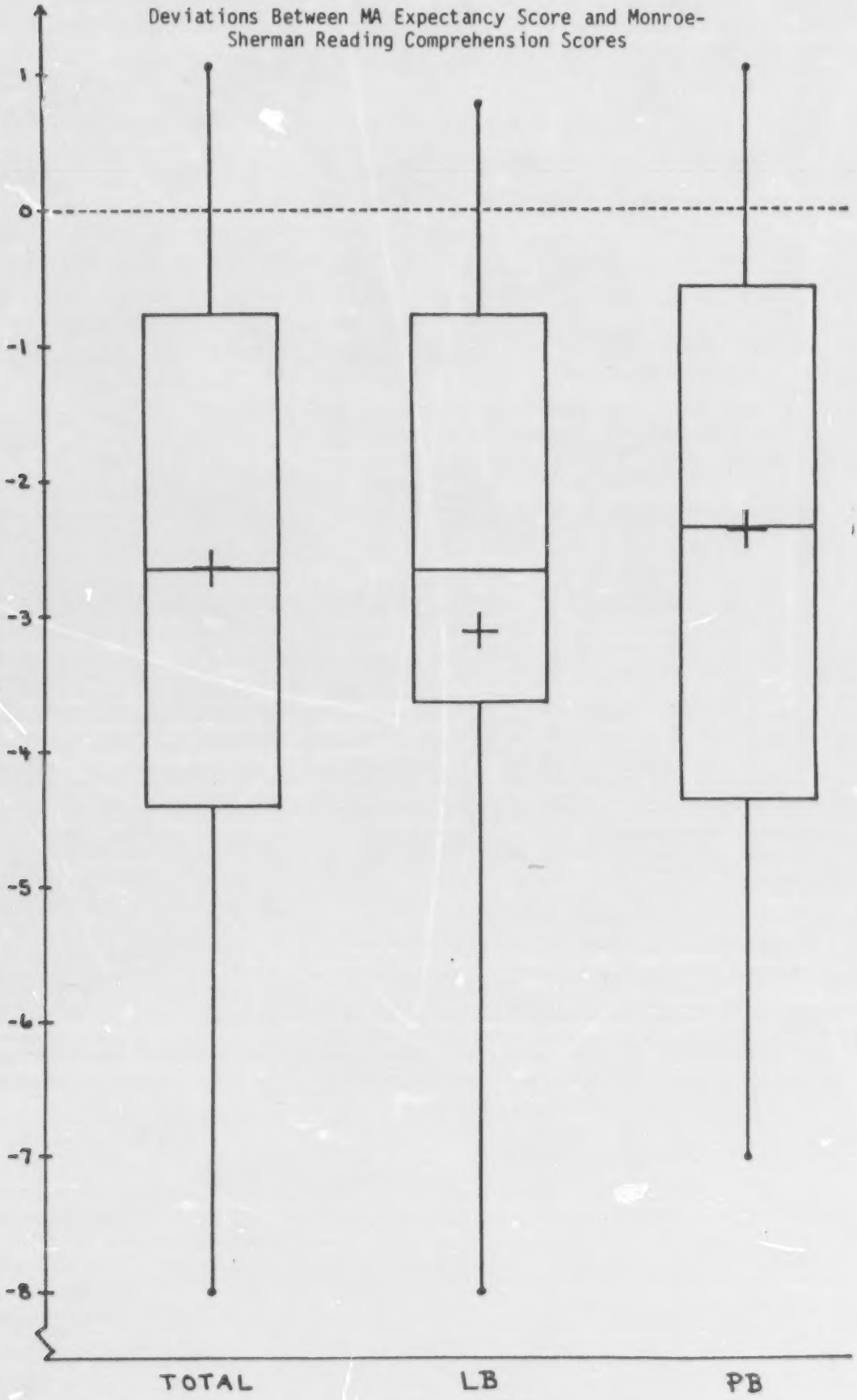


FIGURE 12

Deviations Between MA Expectancy Score and Monroe-Sherman Reading Comprehension Scores



D. The Relationship of Achievement Variables to Cognitive, Neuropsychological, and Visual Factors

Hypothesis 3.1

Reading deficits are more closely related to cognitive factors and postive neuropsycholological signs than objective measures of visual acuity.

Hypothesis 3.2

Deficits in mathematics achievement are more closely related to cognitive factors and positive neurological signs than objective measures of visual acuity.

Methods of Data Collection and Analysis

Reading and math deficits were defined as the measured difference between the subject's expectancy score (derived from number of years in school) and actual measured achievement on the WRAT and Monroe-Sherman. The variable, cognitive factors, was defined as the subject's verbal IQ derived from the WISC/WAIS. The variable, positive neuropsychological signs, was defined as explicated in hypothesis 3.0, separately for the age groups 9-14.11 and 15 and older. The variable, objective measures of visual acuity, was defined as a disability percentage using The Pennsylvania Bureau of Vocational Rehabilitation Assignment Chart, by assigning a disability factor to the best eye with the best correction, for each subject. The test statistic for testing the hypothesis that the correlation between variables x and y equals the correlation between the variables x and z, where x was academic achievement, y, Verbal IQ, Rules, or N+, and z, the visual disability factor, was taken from Glass and Stanley (1970).

Results

The results of the analysis are presented in Table Thirteen. Hypothesis 3.1 was clearly supported at the .05 level of confidence

with regard to reading deficits but not reading comprehension. The correlations between reading decoding deficits with Verbal IQ, Rules, and N+ were significantly greater than the correlations of reading deficits with objective measures of visual acuity. The correlations between reading comprehension, Verbal IQ, and Rules and reading comprehension with visual acuity did not differ significantly, although the results were in the direction of the stated hypothesis.

Hypothesis 3.2 was not supported at the .05 level; however, Table Thirteen clearly indicates that the results were in the direction of the stated hypothesis. In all cases, there was virtually no relationship between math deficits and visual acuity, although math deficits were positively related to Verbal IQ and Rules, and significantly related to N+($p=.05$).

These data supported the position that objective measures of distance visual acuity (excluding etiology or visual functioning) are poor predictors, in and of themselves, of academic performance. The data do, however, indicate that the important underlying variables are cognitive and neuropsychological.

Discussion: The Relationship of Achievement Variables to Cognitive, Neuropsychological and Visual Factors.

The traditional practice of assigning individuals to special education programs for the visually impaired on the basis of measured visual acuity alone is obviously inadequate. It might well be that a determination of a percentage of vision loss is the least important factor in educational placement and planning decisions for this disability group. Higher-level brain functions involving symbolic and semantic

contents are more importantly contingent upon the integrity of neuroanatomical mechanisms. No appropriate instructional activities can be prescribed for the visually impaired without the provision of a detailed profile of levels of neuropsychological functioning.

TABLE 13

Test of Significance Between Pearson Correlations of Five Variables:
Visual Acuity, Neuropsychological Functioning (Rules and N+),
Reading Achievement, Math Achievement, and Verbal IQ

N	r	r	r	z	
50	WRAT reading delay/ VIQ 0.3193	WRAT reading delay/ Visual Acuity -0.1173	VIQ/VA -0.1797	2.148	Level of Significance .016
50	WRAT math delay/ VIQ 0.2604	WRAT math delay/ Visual Acuity -0.0393	VIQ/VA -0.1797	1.432	Not significant .076
50	reading comprehension delay/VIQ 0.2420	reading comprehension delay/Visual Acuity -0.0463	VIQ/VA -0.1797	1.371	Not significant .085
27	WRAT reading delay/ Rules 0.5338	WRAT reading delay/ Visual Acuity -0.0607	Rules/ VA -0.2384	2.289	.011
27	WRAT math delay/ Rules 0.2343	WRAT math delay/ Visual Acuity -0.0044	Rules/ VA -0.2384	0.810	Not significant .209
27	reading comprehension delay/Rules 0.1649	reading comprehension delay/Visual Acuity 0.0973	Rules/ VA -0.2384	0.227	Not significant .410
17	WRAT reading delay/ N+ 0.2459	WRAT reading delay/ Visual Acuity -0.2634	N+/VA 0.0392	1.648	.050
17	WRAT math delay/ N+ 0.5152	WRAT math delay/ Visual Acuity -0.0096	N+/VA 0.0392	1.780	.038
17	reading comprehension delay/N+ 0.4631	reading comprehension delay/Visual Acuity -0.1440	N+/VA 0.0392	2.068	.019

E. The Relationship of Cognitive Variables to Ocular Pathology and Neuropsychological Variables

Hypothesis 4.0

> The frequency of positive neurological signs will differ significantly between subjects with simple refractive errors and those whose etiology relates to retinal involvement.

Methods of Data collection and Analysis

Each subject in the 9 to 14.11 age group and each subject in the above 15 age group was administered the Halstead-Reitan Neuropsychological Battery. A "plus sign", or positive neurological indicator, was assigned to each score that did not fall within the range of normal variation as described by the test publisher for the age group above 14.11. The frequency data for each of the two groups were pooled and a simple t-test was applied to determine whether the means differed significantly at the .05 level.

Results

Hypothesis 4.0 was not supported at the .05 level.

Hypothesis 4.1

> There is a significant positive correlation between deficits in cognitive development as measured by the Piagetian Assessment Battery and delayed neurological development.

Methods of Data Collection and Analysis

Each subject was administered the Piagetian Assessment Battery to determine levels of cognitive development and the Halstead-Reitan Neuropsychological Battery to measure a wide-range of brain-related functions. The data derived from the Piagetian Assessment permitted the formation of three distinct groups which were determined on the basis of cognitive functions being absent, in transition or achieved. Standardized age norms were used for both Concrete and Formal

Operations. Analysis of variance techniques were applied to determine the relationship of cognitive development to the frequency of positive neurological indicators resulting from the Halstead-Reitan Assessment.

Results

Although three of the analyses yielded differences which were not significant at the .05 level, there was a definite observable trend in the direction of the stated hypothesis; that is, there was a positive, but statistically nonsignificant relationship between increased competency on the Piagetian tasks and a decrease in the frequency of positive signs of neurological impairment on the Halstead Reitan. For the 15 plus age group, there was a significant relationship between a deficiency in concrete operational thought and positive neurological signs (F-probability = 0.04).

Discussion: The Relationship of Cognitive Variables to Ocular Pathology and Neuropsychological variables

Hypothesis 4.0 was not supported, and a statistically significant relationship could not be established between frequency of postive neurological signs and retinal and refractive ocular pathology. Unfortunately, ophthalmological diagnoses were skewed somewhat positively in the direction of non-retinal involvement, a factor which was not subject to direct control in the research design. Nevertheless, there were definite indications in the data that a comparison involving equal samples of these two diagnostic groups might yield results that are statistically significant.

The finding of a positive, but statistically nonsignificant, relationship between delayed cognitive development and indices of neurological involvement contributes additional support to one of the

central research assumptions: that the sighted, visually impaired population in the schools is similar on a number of variables to the population classified as learning disabled. The statistically significant relationship between neurological involvement and a deficiency in concrete operational thought in the 15-plus age group underscores the necessity of obtaining profiles of neuropsychological characteristics for the visually impaired population. It would seem from these results that appropriate educational placements and planning cannot be reliably implemented without information regarding the biological condition of the brain. The evidence produced by the present research clearly indicated that this sample includes both learning disabled and brain-damaged subjects at a substantial level. Further, the evidence of a relationship between delays in certain cognitive functions and underlying neurological involvement indicates that to meet appropriately the educational needs of this group is far too complex a matter to be determined on the basis of measured visual acuity for distance alone.

F. Rules Analysis, Impairment Index and Factor Analysis

Selz and Reitan (1980) developed a system of Rules Analysis for classifying 9-14 year-old children as normal, learning disabled, or brain-damaged. The system involves 37 Rules which are based on neuropsychological test data and Reitan's four methods of inference: level of performance, right-left differences, patterns of performance and pathognomic signs. A four-point scaled system was developed for scoring the test data: an adequate performance on a task was scored "0", a "3" was assigned to a distinctly abnormal performance, and scores "1" and "2" were used to indicate intermediate performances. Reitan and Selz (1980) found that many learning disabled subjects appeared to be normal on physical neurological examinations. The researchers suggest that neuropsychological screening for learning disability may be significantly more effective than neurological screening.

In the present study the 27 subjects in the 9 to 14.11 age group were administered the complete Halstead-Reitan Neuropsychological battery. The resultant data were analyzed by the Rules method which yielded the following classifications: 8 of the subjects were classified as Brain-Damaged; 16 were classified as Learning Disabled; and only 3 of the subjects earned total scores which were in the Normal Range (Table Fourteen). The incidence of learning disability and structural brain damage in the sample obviously far exceeds the incidence of the same disorders in the general population. These findings dramatically confirmed the researchers' principal assumption that the sighted, visually impaired are significantly different neurologically from the general population.

The 17 subjects in the age 15 and above category were also

administered the complete Halstead-Reitan Battery, and the results were used to compute an Impairment Index. The Halstead Impairment Index is determined by adding the number of tests in Halstead's Battery on which scores fall into the range characteristic of individuals with cerebral damage. The total is then divided by 10, which is the number of tests in the Halstead Battery. The Impairment Index may range from 0.0 to 1.0. An Impairment Index between 0.0 and 0.4 is within the normal range of variability; an Index of 0.5 and above is within the Brain-Damaged Range. Eight of the 17 subjects, or 47%, had Impairment Indices in the Brain-Damaged Range (Table Fifteen).

Thirty-two subjects, or 65% of the total sample, were classifiable as either brain-damaged or learning-disabled. This finding alone indicates that a neuropsychological assessment should be a requisite component of any evaluation of sighted, visually impaired subjects for educational placement and planning purposes.

To further clarify the relationships among variables in the study, a factor analysis was computed using data from the total sample, including the 11 subtests of the WISC-R/WAIS, the visual disability variable, the Halstead-Reitan Category Test, and Rules Analysis. A principal component analysis with a normal varimax rotation was applied to 14 variables. A factor loading $\geq$ .50 was the criterion for inclusion of a variable in the interpretation of a factor. The results are presented in Table Sixteen.

Three principal factors were extracted from the data. Factor I was labeled the Verbal Factor on which the Wechsler Verbal Scale subtests, with the exception of Digit Span, had the highest loadings. Factor I accounted for 34% of the total test variance. Factor II was labeled the Performance Factor and was defined by criterion loadings of all

the subtests of the Wechsler Performance Scale and the visual disability variable. Factor II accounted for 27% of the total test variance. Factor III, which accounted for 14% of the total test variance, was labeled the Attention/Distraction Factor because of heavy loadings of the Arithmetic and Digit Span subtests. The Halstead-Reitan Category Test was heavily loaded on Factor III. The overall results of the factor analysis were similar to other investigations of the WISC-R/WAIS which have delineated two principal factors, Verbal and Performance (Sattler, 1974). Factor III, the Attention/Distraction Factor, is similar to the Freedom from Distraction Factor, identified by Cohen's (1959) factorial investigation of the WISC.

The factor analytic results confirmed that the visual disability variable, defined as distance visual acuity expressed as a percentage of loss, contributed to variance in the Performance, but not the Verbal subtests at the criterion level. It must be emphasized that the visual disability variable was computed only on the basis of distance Snellen notation and did not take into account etiology or near vision functioning. Although other analyses performed in the study confirmed that visual acuity was not significantly related to academic achievement or motor performance (for older students), it did emerge as a salient variable in the Performance Factor. One inference that can be drawn from this finding is that, while assumptions regarding academic, motor and levels of neuropsychological functioning are definitely not warranted on the basis of measured visual acuity alone, measures of distance visual functioning are clearly associated with psychomotor development.

A significant finding, with definite implications for the

development of a paradigm for psychoeducational assessments of the visually impaired, is that Rules Analysis loaded on heavily with the Verbal Factor. The application of Rules Analysis to performance results on the Halstead-Reitan Battery can provide significant detailed information regarding a broad range of verbal and language functions. Reitan (1980) confirmed a basic postulate that learning disabled children tend to perform poorly on tests that measure higher-level brain functions such as the processing of verbal information. Given the evidence in the results of the present study that the sighted, visually impaired population in the public schools includes a high percentage of learning disabled children, it is obvious that the Halstead-Reitan Battery should be an integral part of psychodiagnostic and psychoeducational assessments of the visually impaired.

Table 14

Rules Analysis Summative Scores for the 9-14.11 Age Group

Subject	Score	Category
1	68	Brain-Damaged
2	28	Learning Disabled
3	44	Brain-Damaged
4	25	Learning Disabled
5	22	Learning Disabled
6	27	Learning Disabled
7	27	Learning Disabled
8	18	Normal
9	43	Brain-Damaged
10	21	Learning Disabled
11	55	Brain-Damaged
12	38	Brain-Damaged
13	21	Learning Disabled
14	56	Brain-Damaged
15	21	Learning Disabled
16	22	Learning Disabled
17	25	Learning Disabled
18	27	Learning Disabled
19	16	Normal
20	38	Brain-Damaged
21	20	Learning Disabled
22	26	Learning Disabled
23	27	Learning Disabled
24	12	Normal
25	31	Learning Disabled
26	43	Brain-Damaged
27	23	Learning Disabled

RULES SCORING CLASSIFICATION*

	Normal	LD	BD
Rules System Ranges	19 or below	20-35	36 or above
	(Controls)		
Range of Scores	1-25	8-43	11-74
Mean Scores	10.60	24.44	40.60
Standard Deviation	6.62	9.61	18.51

differences sig. beyond .001 level

*(Selz and Reitan, 1980)

Table 15

Impairment Indices for the Age Group 15 and Above

Subject	Index	Category
1	.2	Normal
2	.4	Normal
3	.7	Brain-Damaged
4	.1	Normal
5	.0	Normal
6	.6	Brain-Damaged
7	.4	Normal
8	.1	Normal
9	.6	Brain-Damaged
10	1.0	Brain-Damaged
11	1.0	Brain-Damaged
12	.6	Brain-Damaged
13	.7	Brain-Damaged
14	.3	Normal
15	.1	Normal
16	.7	Brain-Damaged
17	.4	Normal

Note: Some of the subjects classified as "normal" in this group exhibited symptoms of learning disorders. However, this analysis involved only indices of structural cerebral damage.

TABLE 16

Rotated Factor Loading Matrix for Visual Acuity, WISC-R/WAIS Subtest Scaled Scores, Category Test and Rules Score

	FACTOR 1	FACTOR 2	FACTOR 3
Comprehension	0.911*	0.000	0.261
Similarities	0.892*	0.000	0.000
Vocabulary	0.877*	0.000	0.000
Information	0.868*	0.000	0.000
Arithmetic	0.720*	0.000	0.491*
Rules	-0.578*	-0.430	-0.406
Coding/Digit Symbol	0.000	0.811*	0.000
Picture Arrangement	0.303	0.786*	0.000
Object Assembly	0.000	0.783*	0.000
Picture Completion	0.290	0.742*	0.000
Visual Acuity	0.461	-0.674*	-0.306
Block Design	0.404	0.619*	0.000
Digit Span	0.320	0.000	0.868*
Category Test	0.000	0.385	0.697*
Variance Explained	4.724(34%)	3.752(27%)	1.919(14%)

*The above factor loading matrix has been rearranged so that the columns appear in decreasing order of variance explained by factors. The rows have been rearranged so that for each successive factor, loadings greater than 0.5000 appear first. Loadings less than 0.2500 have been replaced by zero.

IV SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This study was conducted to provide a comprehensive developmental profile of the sighted, visually impaired child in the areas of cognitive, psychomotor, academic and neuropsychological functioning. Fifty visually impaired students were studied on 143 variables over an 18 month period with the Halstead-Reitan Neuropsychological Battery, Piagetian Assessments and standardized achievement tests.

The results substantiated that the sample was characterized by significant delays in cognitive, psychomotor and academic functioning. Neuropsychological assessment results clearly substantiated that the sample was most similar to the learning disabled in relation to neurological characteristics and academic deficits.

A significant finding was that 16 of the subjects were diagnosed as brain damaged on the basis of the application of the Rules Analysis and Impairment Index to the Neuropsychological protocols. To date, five of these subjects have been referred to neurologists for further assessment and treatment. Three subjects have subsequently been diagnosed as epileptic, one as cerebral palsied, and one as having a generalized cerebral encephalopathy. All these subjects received medication for seizure disorders. This finding further underscores the need for inclusion of neuropsychological assessment in the evaluation of the visually impaired. Not only did the neuropsychological assessments yield important data for educational planning, but also provided critical data on the biological condition of the brain which had important implications for health management.

The results of the study clearly indicate the need for neuropsychological information in making educational decisions for visually impaired

students. A comprehensive assessment should include:

1. An ophthalmological and general medical examination.
2. An intellectual assessment with the Wechsler Scales including both Verbal and Performance Scales, if the student has usable vision.
3. A personality assessment.
4. An evaluation of achievement levels in basic academic skills. (Word Decoding, Reading Comprehension, Arithmetic Computational Skills, Spelling).
5. A comprehensive neuropsychological assessment with the Halstead-Reitan Battery.

Assessments of preschool-aged children would, of course, have to be modified appropriately.

The results of the study also have clear implications for educational programming for the visually handicapped, whose developmental, cognitive, academic and neuropsychological profiles document a significantly high incidence of learning disabilities. The sample profiles suggest that educational programs designed for the visually impaired must address specific academic remediation in reading, mathematics and language skills in addition to an academic curriculum which stimulates cognitive development and a psychomotor curriculum designed to stimulate perceptual-motor functioning. The learning needs of the visually impaired identified in the present study also have important implications for teacher preparation programs which train teachers of the visually handicapped. It is suggested that, in addition to the specialized competencies of braille and mobility, teachers of the visually handicapped require training similar to that provided for teachers of the learning disabled. Such training would include the acquisition of competencies in diagnostic teaching, academic remediation and

educational assessment. If teacher roles are defined by documented student needs, it is obvious that teachers of the visually handicapped must master a core of generic competencies common to all special education teachers.

The results of the present study generated provocative ideas for future research. It is suggested that the Halstead-Reitan assessment be replicated with a much larger sample of the visually impaired to further examine and substantiate the results of the present study. A similar study could be conducted with a sample of subjects identified as learning disabled, to provide comparative data.

Data from this study also suggest that there is a need to create a model experimental program for educating visually impaired children which addresses their specific learning needs. Such a model would combine the special skill areas with pedagogy validated for the learning disabled.

APPENDIX A

VITAE OF PRINCIPAL INVESTIGATORS

Personal Data:

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Educational Background

School	Year Graduated	Degree	Major
Duquesne University	1976 - Present		Advanced School Psychology Program
University of Pittsburgh	1975	Ph.D.	Curriculum and Supervision
University of Pittsburgh	1970	M.Ed.	Education of the Visually Handicapped
Duquesne University	1969 Magna Cum Laude	B.A.	Psychology

Certification:

Permanent - Pennsylvania - Education of the Visually Impaired

Permanent - Pennsylvania - Supervisor, Special Education

Permanent - Orientation and Mobility Specialist

Teaching Experience:

Instructor, University of Pittsburgh, Division of Specialized Professional Development, 1973 - present. Responsible for coursework and practicum experience in the area of orientation and mobility, Education of the Visually Handicapped.

Itinerant teacher/Orientation and mobility specialist for the visually handicapped. Westmoreland, Pennsylvania Intermediate Unit #7, 1970-71.

Itinerant teacher/Orientation and mobility specialist for the visually handicapped. Pittsburgh Public Schools, 1971-74.

Supervisory Experience:

Supervisory Instructional Specialist, Program for the Visually Impaired, Pittsburgh Public Schools, 1974-1978.

Supervisory Instructional Specialist, Handicapped, Pittsburgh Public Schools, 1978 - present.

Consultant Experience:

Consultant, Pennsylvania Department of Education, Teacher Competencies for Implementation of Public Law 94-142, June - October, 1979.

Consultant, Piagetian Approach to Visually Handicapped Education, University of Texas at Dallas, Columbus, Ohio, June, 1979.

Consultant, Monterey Learning Systems, Inc., Palo Alto, California, 1977.

Consultant, Western Pennsylvania School for Blind Children, Secondary Curriculum Development Project, 1976.

Consultant, Western Pennsylvnia School for Blind Children, Early Education Curriculum Development Project, 1973-74.

Project Field Reader, Department of Health, Education, and Welfare, January, 1979, October, 1979.

Presentations:

Overview of the Research: An Investigation of the Learning and Developmental Characteristics of the Sighted, Visually Impaired Child, Pennsylvania Council for Exceptional Children, Pittsburgh, Pennsylvania, October, 1979.

"Adaptations of Traditional Orientation and Mobility Techniques for the Severely Multiply-Handicapped Blind Child." Pennsylvania Council for Exceptional Children, Philadelphia, Pennsylvania, October, 1978, Pittsburgh, Pennsylvania, October, 1979.

"The Psychological Assessment of the Pre-school Visually Impaired Child." Coordination and Outreach Network for the Needs of Exceptional Children Today, Butler, Pennsylvania, March, 1978.

"The Role of the Teacher in the Due Process Hearing." Council for Exceptional Children, Kansas City, Missouri, 1978.

"Leadership Roles in Developing and Implementing an IEP." Workshop presentor, Council for Exceptional Children, Albuquerque, New Mexico, 1978.

Presentations (Continued):

"Use of the Monterey Learning Systems to Improve the Reading and Mathematics Achievement of Visually Impaired Learners." Association for the Education of the Visually Handicapped, Pittsburgh, Pennsylvania, 1977.

"Educational Implication of a Visual Handicap." Pittsburgh Ophthalmological Association, Pittsburgh, Pennsylvania, October, 1976.

"Current trends in the Education of the Visually Handicapped." Pennsylvania Council for Exceptional Children, Philadelphia, Pennsylvania, October, 1976.

"Love in the Classroom." Pennsylvania Council for Exceptional Children, Philadelphia, Pennsylvania, October, 1972.

Grants Received:

An Investigation of the Learning and Developmental Characteristics of the Sighted, Visually Impaired Child. Grant No. G007901959 Handicapped Research and Demonstration, August, 1979 - December, 1980.

Honors Received:

Departmental Award for Excellence in Psychology, Duquesne University, 1969.

Fellowship, University of Pittsburgh, 1969-1970.

Graduate Research Assistantship, University of Pittsburgh, Summer, 1971.

Membership in Professional Organizations:

Council for Exceptional Children, DVH, CASE.

Association for the Education of the Visually Handicapped.

Publications:

"Monterey Learning Systems: Improving Academic Achievement of Visually Impaired Learners," Journal of Visual Impairment and Blindness, September, 1977.

Development and Utilization of a Conceptual Model to Explore the Relationship of Selected Research Variables to Female Choice of Occupational, Vocational, or Technical Programs. Unpublished Doctoral Dissertation, University of Pittsburgh, 1975.

"Where are the Girls?" Journal of the Pennsylvania Federation Council for Exceptional Children, July, 1974.

"Listening Skills: A Review of the Literature," The New Outlook for the Blind, October, November, December, 1974.

VITAE

Name: Michael Moran

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Present Position:

Since 1969 Dr. Moran has been employed as an Associate Professor of School and Developmental Psychology, Graduate School of Education, Duquesne University, Pittsburgh, Pa., 15219. Additionally, he is President and Director of Clinical Services, Psychological Specialists, Incorporated, Suite 1708 Lawyers Building, 428 Forbes Ave., Pittsburgh, Pa. 15219, telephone: (412) 281-1320. Private practice specialties include neuropsychological assessments, group and individual psychotherapy, and psychoeducational evaluations.

Education:

B.S. magna cum laude, Penn State University, 1958

M.S., Penn State University, 1961

M.A. (Educational and Developmental Psychology), Michigan State University, 1964

Ph.D. (Rehabilitation Counseling and Educational Psychology), University of Pittsburgh, 1969

Credentials and Professional Organizations:

Licensed Psychologist in Pennsylvania (Lic. No. 225)

Certified School Psychologist, Pennsylvania & West Virginia (209-20-2173)

Listed in the National Register of Health Services Providers in Psychology

Member of American Psychological Association (four divisions)

Associate Editor of The School Psychologist, Official Publication of Division 16 of the American Psychological Association

Clinical Member of the American Association of Marriage and Family Counseling

Member of the Pennsylvania Psychological Association

Member of the Greater Pittsburgh Psychological Association

Member of the American Personnel and Guidance Association

Member of the National Rehabilitation Association

Member of Phi Kappa Phi, National honorary society

Publications

Articles

"The Effects of Differential Training on the Risk Variable in the Counselor Decision-Making Process." Rehabilitation Research and Practice Review, Vol. 2, No. 3, Special Summer Issue, 1971.

"A Scale for Measuring the Risk-Taking Variable in Rehabilitation Counselor Decision-Making." Rehabilitation Counseling Bulletin, Vol. 15, No. 4, June, 1972.

"Rehabilitation Counseling: Goals and Techniques." Guidance Educator, Duquesne University, October, 1972.

Book

Moran, Michael, ed. Developmental Psychology: Selected Readings. Simon and Schuster, N.Y., 1972.

Papers

"The Client Selection Process," paper delivered at the National Rehabilitation Association Convention, New York, 1974.

"The Effects of Differential Educational Environments on the Rate of the Development of Moral Judgment," paper presented at the American Psychological Association Convention in Montreal, 1975.

"Therapeutic Communication Techniques," paper presented to the Pennsylvania Nurses Association, Pittsburgh, 1976.

"Neuropsychological Assessment Techniques," paper presented to professional staff of the Pennsylvania Bureau of Vocational Rehabilitation, Pittsburgh, 1979.

"Neuropsychological, Learning, and Developmental Characteristics of the Sighted, Visually Impaired Child," paper presented at the American Psychological Association Convention, Montreal, 1980.

APPENDIX B

DESCRIPTION OF THE HALSTEAD-REITAN

NEUROPSYCHOLOGICAL TEST BATTERY

Description of the Halstead-Reitan Neuropsychological Test Battery

The Halstead-Reitan Neuropsychological Test Battery is used to assess brain functions and to diagnose neurologically based learning disorders. The following is a brief description of each test included in the battery:

1. The Wechsler Intelligence Scale for Children (Revised): The WISC-R is an individually administered intelligence test composed of 12 subtests, which are divided into Verbal and Performance Groups. The Verbal Tests include Information, Similarities, Arithmetic, Vocabulary, Comprehension, and Digit Span; The Performance Tests include Picture Completion, Picture Arrangement, Block Design, Object Assembly, Coding and Mazes. In addition to the Verbal and Performance I.Q.'s, the test also yields a Full-Scale I.Q. Scaled scores earned on individual subtests provide clinically significant information. The Wechsler Adult Intelligence Scale was administered to subjects over age 16.

2. Category Test: This test utilizes a projection apparatus for presentation of stimulus configurations on a milk-glass screen. The respondent is required to discern a principle involved in each set of configurations. He indicates his discernment of the principle by depressing one of four levers. A resultant bell or buzzer sound informs the respondent whether his answer is right or wrong. The test is designed to measure competence in abstraction ability and basic perceptual and conceptual abilities. Further, the test measures the extent to which the respondent can profit from both positive and negative reinforcement in terms of making appropriate adaptive responses.

3. Tactual Performance Test (Time, Memory and Localization): This test is actually a mofification of the Seguin-Goddard form board. The subject is blindfolded before the test begins and is asked to fit variously shaped blocks

into their proper spaces on the board. For the first trial the subject uses his preferred hand, then his non-preferred hand, and for the third trial he is asked to perform the same tasks using both hands. The test is designed to measure tactile form discrimination, kinesthesis, upper extremeties motor coordination, manual detexerity, and visualization of spatial configurations and spatial interrelationships.

4. Finger Oscillation Test: This test is a measure of finger-tapping speed using a specially adapted, mounted manual tapping apparatus. Measurements are made in 5 consecutive 10 second trials in which the respondent must sustain the tapping motion, first with the index finger of the preferred hand, and then with the index finger of the non-preferred hand. Results on this test provide an index of motor speed and the ability to sustain a purely motor task.

5. Rhythm Test: The Rhythm Test is a subtest of the Seashore Tests of Musical Talent. The subject is required to differentiate between 30 pairs of rhythmic beats which are sometimes the same and sometimes different. Performance on this test requires alertness to nonverbal auditory stimuli, sustained attention, and auditory discrimination.

6. Speech-sounds Perception Test: This test consists of 60 spoken nonsense words. The subject is required to underline the spoken syllable, selecting the correct answer from four alternatives printed on an answer form. The test requires the respondent to correctly perceive a stimulus through the auditory mode, and then to relate the perception through vision to the correct configuration of letters on the answer form.

7. Marching Test: This test is designed to evaluate gross skeletal muscular function. The respondent is required to connect circles with a line to

indicate the correct progression of a marching sequence. The test includes trials for both the preferred and non-preferred hands.

8. Color Form Test and Progressive Figures Test: These two tests are designed to provide measurements of organizational ability, abstraction concept formation, and cognitive flexibility. The subject is required to make a series of sequential moves based on color and shape stimuli.

9. Aphasia Screening Test: This test provides an extensive survey of possible aphasic and related deficits. The subject is required to name common objects, spell simple words, read, write, calculate, enunciate, understand spoken language, identify body parts, differentiate right from left, and copy simple shapes.

10. Wide Range Achievement Test (WRAT): This is an achievement test which yields grade equivalent scores in Reading, Arithmetic and Spelling.

11. Target Test: This test consists of a stimulus figure affixed to a wall in front of the subject. The examiner, using a pointer, taps out a design on the dots of the stimulus figure. The respondent is required to watch the tapping performance, and then after a 3 second delay he is required to draw the tapped-out configuration on his answer sheet. The test is designed to provide a measure of the reception and expression of visual-spatial relationships.

12. A variety of sensory-perceptual examinations are also administered.

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